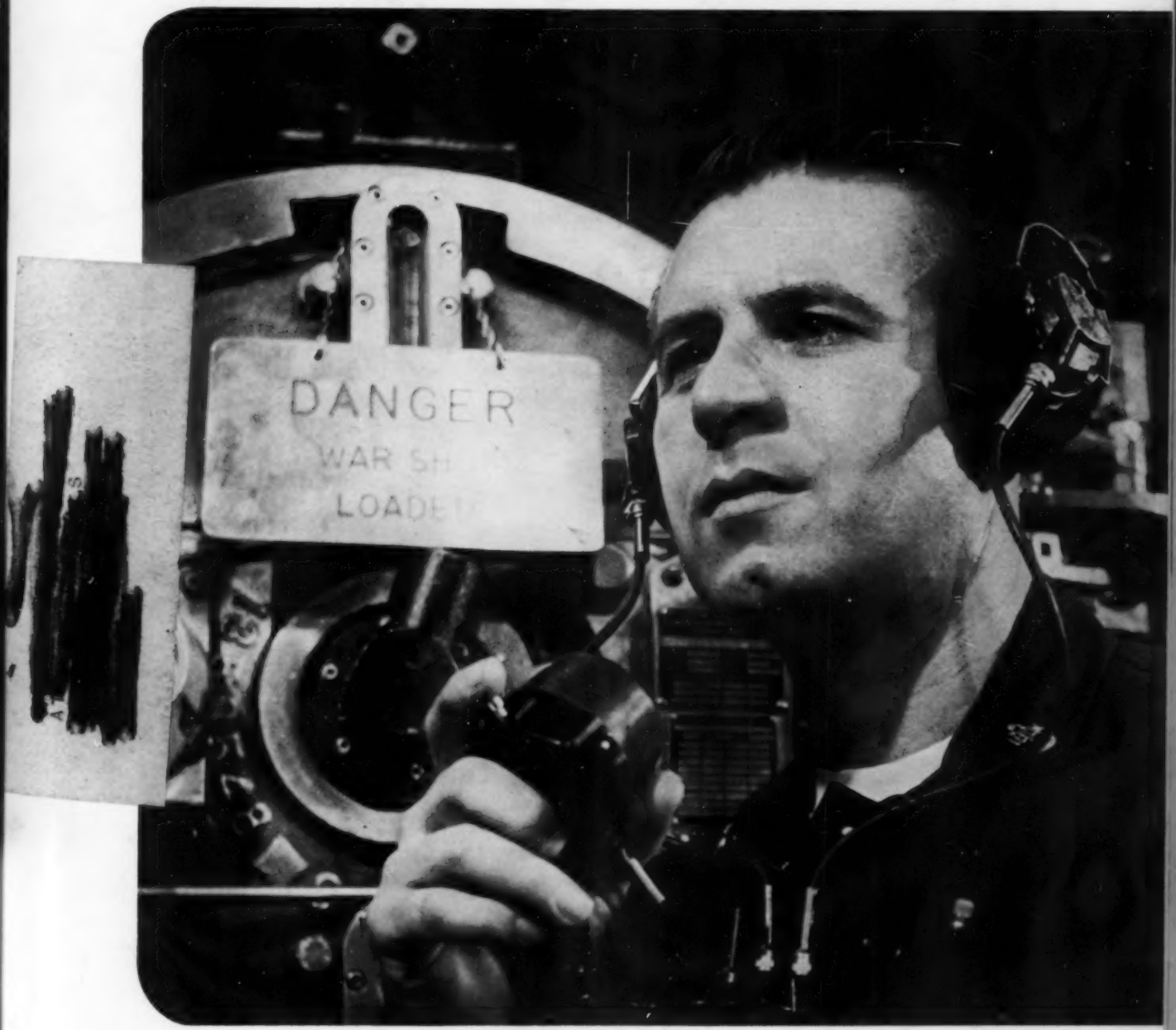
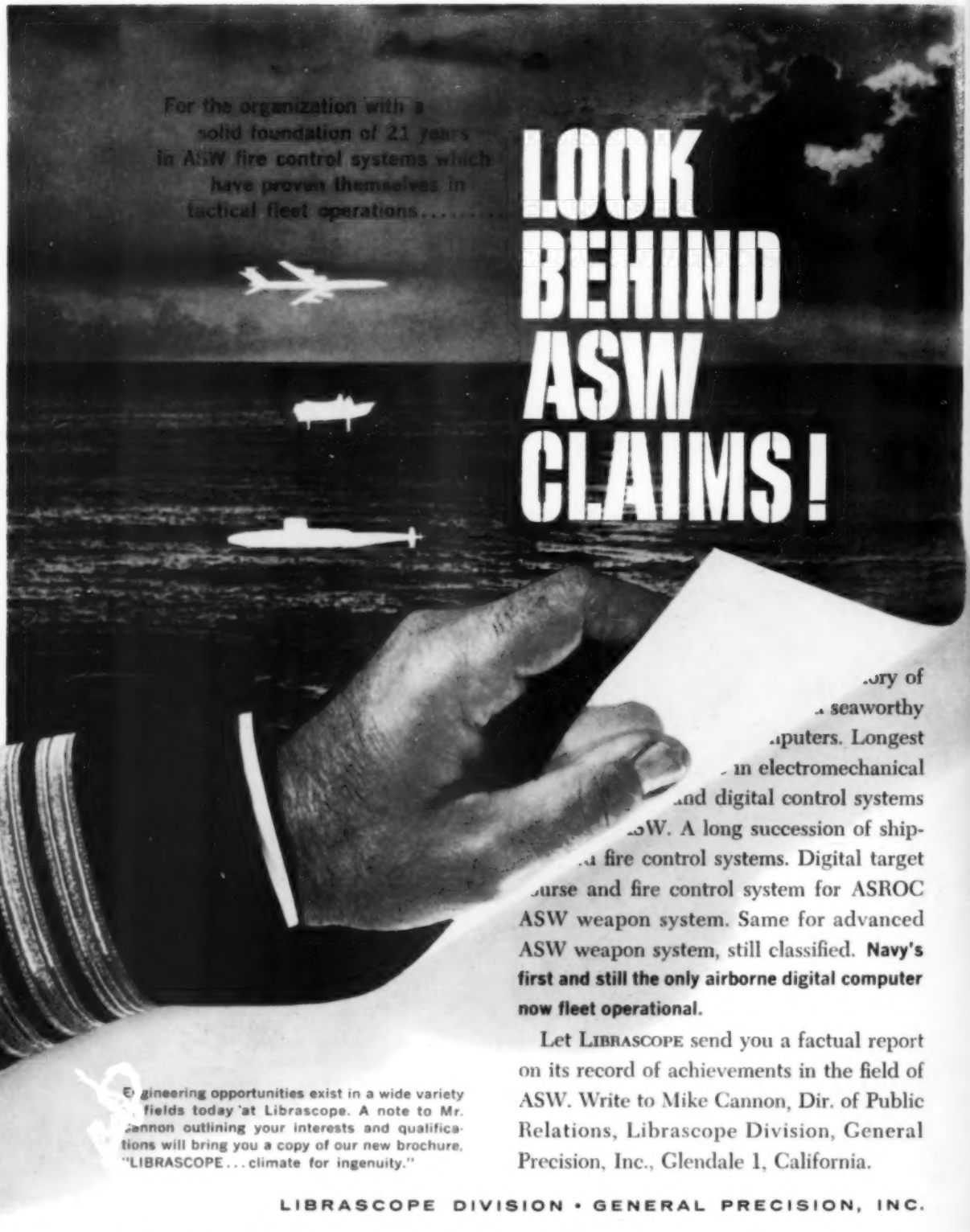
Volume 2, Number 2
MARCH/APRIL, 1961

Underwater Engineering

The Magazine of UST, ASW, PSW and Oceanics



ASW FIRE CONTROL: BASIC PRINCIPLES
MARK 44 EVALUATION: A PICTURE STORY
UE SOUNDINGS: A NEW INDUSTRY SERVICE



...ory of ... seaworthy ...puters. Longest ... in electromechanical ...nd digital control systems ...W. A long succession of ship- ... fire control systems. Digital target ...urse and fire control system for ASROC ASW weapon system. Same for advanced ASW weapon system, still classified. **Navy's first and still the only airborne digital computer now fleet operational.**

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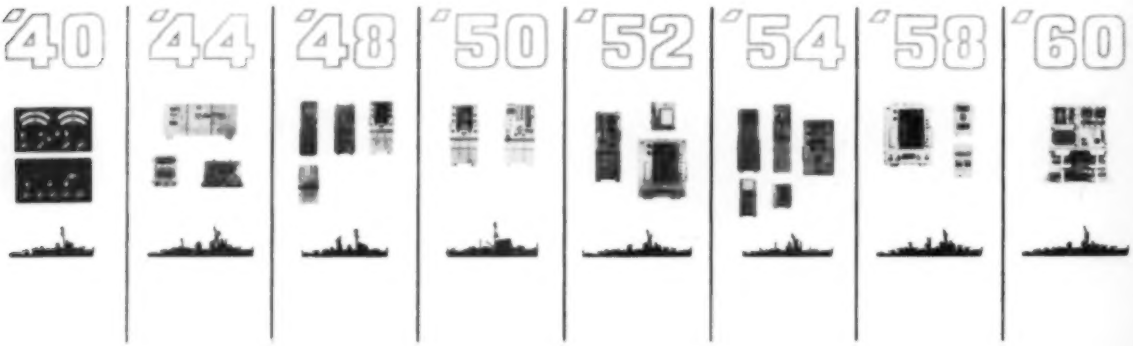

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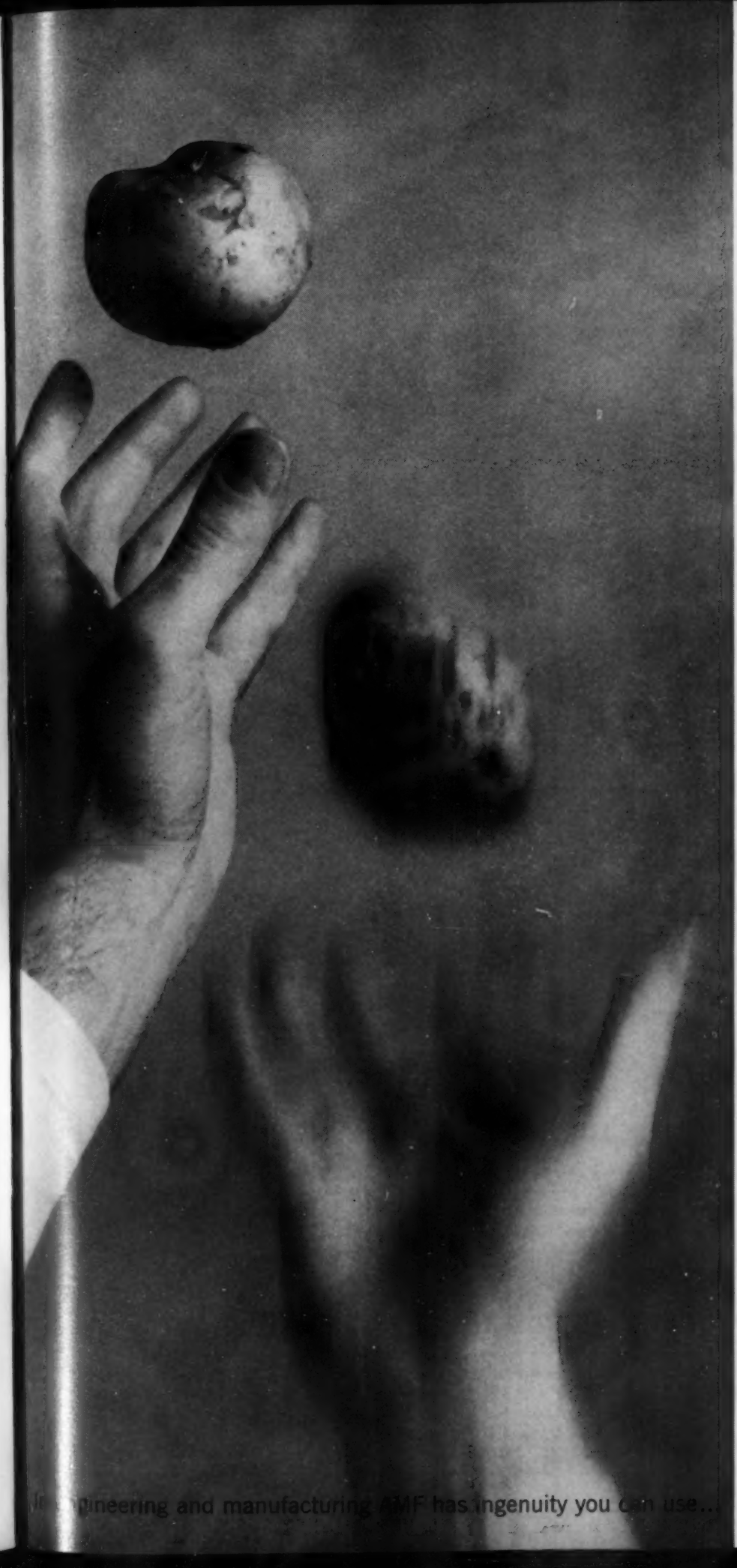

He juggled the hottest potatoes in the Seawolf

...the fuel elements for its nuclear power plant.

Periodically, spent elements must be removed and replaced with fresh ones. The problem—utterly original and fiendishly difficult—was to do the job safely, quickly, and, above all, surely.

This AMF engineer designed the refueling system that did the job. One of his major problems was the fuel elements' liquid sodium environment. Sodium burns fiercely when brought in contact with either air or water. Yet, it had to be exposed during element transfer. Solution: an inert helium blanket to isolate the sodium.

Though awesomely intricate, the refueling machinery had to be designed to work in cramped quarters. The high radioactivity of the environment made the handling problem still more difficult.

That's why, though remotely controlled, all apparatus is *manually* operated. It removes the element and transfers it to a disposal container with complete safety, accuracy, and a degree of reliability that approaches the supernatural.

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underwater engineering

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Accepted as a controlled circulation publication at Shepherdsville, Kentucky.

Printed in Shepherdsville by Publishers Printing Co.

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640 Washington Bldg.
Washington 5, D.C.
DIstrict 7-8570

PICTURE CREDITS: Cover, U.S. NAVY; pp 18-19, U.S. NAVY and GENERAL ELECTRIC CO.; pp 23, LIBRASCOPE DIV., General Precision, Inc.; pp 24-25, MINNEAPOLIS-HONEYWELL REGULATOR CO., GENERAL ELECTRIC CO. and U.S. NAVY; pp 27, U.S. NAVY; pp 30, WOODS HOLE OCEANOGRAPHIC INSTITUTE and MASSACHUSETTS INSTITUTE OF TECHNOLOGY; pp 33, U.S. NAVY; pp 38-39, PORTLAND INDUSTRIES CORP.; pp 49, U.S. NAVY.

cover

UE's cover shows Chief Torpedoman (SS) Tudor F. Davis, USN, of Pottsville, Pa., standing watch in the forward torpedo room of the USS(B)N George Washington after her return from her first operational cruise, during which she patroled her Texas-size on-station duty area for 67 days without surfacing.

★ ★

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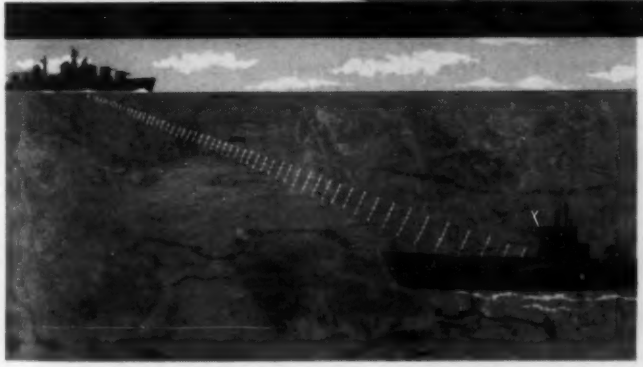
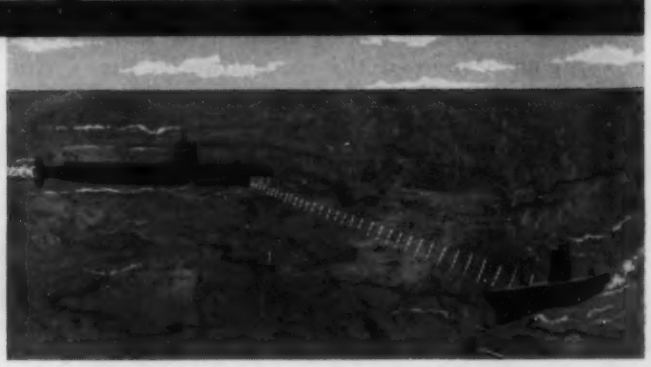
NOTE—Underwater Engineering circulation is executed on a controlled unpaid basis. Engineering and management personnel actively engaged in the areas of undersea warfare and oceanography are considered qualified applicants. Use the self-addressed post card in this issue or write to Circulation Dept., 2775 S. Moreland Blvd., Cleveland. Ohio.





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editorial

let's get off the dime

In case anyone is still in doubt, this magazine is in being to promote, aid, and expedite the development of the great underwater realm that envelopes the majority of this terrestrial sphere. We may chide, carp, and criticize, and we may damn, praise, or extole, but be soever what they may, our words and our voice have one sole objective and none other: This is to provide man with the means to excell in the last and greatest physical environment of earth.

Since his emergence from the dim prehistoric ages of pure instinctivism, man has been a surface creature. Now, in the real time of recent history he has begun to fly in the lower reaches of the sea of atmosphere that enwraps this planet. It even appears as though he might be about to venture timorously into the strange and foreboding vastness of space.

Concurrently, however, we see the building menace and feel the lodestone pull of the depths beneath the waves that clothe our oceans in a kaleidoscope of living moods and colors. Whether it's to effect a firm defense or to launch a grand assault, or whether it's the challenge of the unconquered that's simply there, man is beginning yet another conquest that will demand the utmost of his every skill and daring and will fascinate him for centuries to come.

To quote an oft-stated but still little appreciated cliche of the current fadist era, so-called inner space is less known and less familiar than outer space.

From a military point of view, the oceans pose every bit the threat to and potential for our national safety and well-being. And from the point of view of pure humanity, an intimate understanding of the oceans holds far more promise of benefit in the proximate future than the conglomerate assemblage of energy gradients and high velocity particles known as space.

But professionally speaking, the proponents of the underseas have constructed for themselves a closed and much restricted club. With few, and fortunately notable exceptions, membership today is limited to the membership of yesterday.

America's underseas effort is gliding glibly up the same garden path that in recent years has resulted in our achieving and — even worse — accepting a shameful second-best in space.

Because of the contributions of two vastly different men — namely Admirals Richover and Raborn — we have gotten the jump on the Russians in certain military areas of the underseas. But the exploding panorama of underseas potential in both peace and war presents far more of a challenge than two men alone can ever meet.

Achieving supremacy and understanding in the underseas requires a whole effort — not a fragmented attack.

For example:

• The miriad of baffling problems and unknowns require a full solution and comprehension. This means, as a starter, a major revision in the rules of *security classification* — or at least a knowledge by participants of what *is* and what *is not* under security wraps, so that an eager enquiring industry can at least find out if its worth getting a "need to know." Underseas technology, like space, requires the full effort of American industry — not the limited jealously guarded efforts of the privileged few old time club members.

We don't mean dump our secrets to the enemy. But we do mean: Let American industry know *at least* what the Russians know. It's the best trouble-shooting crew in the world.

• The intellectual inverse square law that seems to afflict the Bureau of Ships. BuShips has done and still does good work. But it can do a lot better. For example, look for answers rather than subverting solutions; get off the NIH kick; and don't be so jealous of Special Projects Branch. So it's cut into your budget: Think of the potential it has opened up. . . . And what is true of BuShips, is also true to a degree of BuWeaps.

• The all talk and no do of the White House and Congress when it comes to putting up the money. Underseas technology is like the weather and schools . . . as we said: All talk and too little do.

In a word, the oceans are an all-out environment. They take an all-out effort. Let's get on with it before the Russians here, as well as in space, suddenly surge into first place.

Seabrook Hull

THIRD EXPANSION IN 15 YEARS

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The MASSA DIVISION of Cohu Electronics, Inc., is a pioneer in the field of electroacoustics, and its contribution to the basic science of acoustics and research accomplishments has established many fundamental concepts upon which this important industry has advanced.

As a result of its diversified electronic developments, the company has just completed its third expansion since its establishment in 1945.

Through contract and proprietary efforts, the company is deeply engaged in the design and production of electronic detection equipment required as a pivotal part of the Nation's Anti-Submarine activities.

MASSA DIVISION is interested in the future, and as the new expansion program progresses, there will be many excellent opportunities for qualified men who are invited to forward their confidential inquiries to the personnel director.

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UNDERWATER SOUND — In addition to its basic SONAR contributions to the U. S. Navy, Massa Hydrophones are used as reference standards by military and industrial organizations engaged in Sonar research and manufacture.

VIBRATION & SOUND PRESSURE — Massa has developed a wide line of precision acceleration (Accelerometers), Sound Pressure (Microphones) measuring systems. These instruments find wide application in ground and airborne missiles, space and aircraft projects.

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UE Soundings

This is a new section of UE. Its basic purpose is: To provide you with a ready reference rundown in following the latest developments in the UE field. Your comments will help us to do the best possible job.

SCANNING

"Puzzle Palace" is a favorite Navy term for the Pentagon, and with each passing day under the new look it grows ever more puzzling. For example, take Defense Secretary McNamara's latest order giving the Air Force complete responsibility for all future responsibilities in outer space.

What's this got to do with undersea technology? Just this: U.S. Navy's got its *Transit* navagation satellite program — as everyone knows — as just one more way to let "Red" Raborn's *Polaris* submarines and other Navy craft know just where they are. And, lately Navy's been pushing submarines as a natural for mobile platforms capable of launching satellites — particularly Anti-Satellite Satellites — from almost any latitude on the earth's surface. AF claims its Strategic Air Command should have control over the Polaris weapons system. At the same time, there's a lot of serious talk going around about using submarines as launching sites for anti-ICBM weapons. If McNamara's order stands, this could just about put the Navy in the Air Force.

Aluminaut is on its way. Complete agreement among the principles has been reached, and work is proceeding towards realization of the 18,000-foot-deep-diving submarine. Reynolds Aluminum Company will fund the boat. Electric Boat div. of General Dynamics will build it. It will be leased to Woods Hole Oceanographic Institute, which will use it in a research program funded by Office of Naval Research.

Latest design changes in *Aluminaut* include: Switch from hemicylindrical hull sections 80 inches long with a 3½ foot radius to cylinders 40 inches long. Plan is to forge hull sections out of aluminum (Wyman-Gorden and ALCOA are bidding for the job). Hull thickness has gone from six to six-and-a-half inches. Streamlining has been improved around the stern access hatch, and a switch has been made from a single swiveling propeller to twin differentially throttled propulsion units mounted externally.

Kennedy's new budget stresses "conventional" as well as nuclear weapons. This means hard emphasis on a ground Army — the foot-slogging kind of war with all of its logistical supply problems. This cannot but mean increased emphasis on anti-submarine warfare.

NAVIGATION, PLOTTING

"Contact Analog" is Navy's latest effort to come up with better and simpler control for submarines. This is a television-display intended to give a single "driver" of a submarine the impression that he is looking through a window in the prow of the ship and can see the ocean surface above, the ocean floor below, and possibly mines or other submarines in the water ahead. He will see what looks like a highway suspended in the water before him. His job is to stay on that highway. Orders from the Captain to ascend, dive, or change course will change the highway's position on the "window". The driver adjusts the submarine to stay straight ahead. The device was successfully tested at sea last month.

TRANSPORTS

Underwater assault transports and cargo carriers is cited by Army Transportation Corps as a must. To quote: "Underwater transport, with its speed and concealment advantages over water surface operation, should be developed as a standard part of Transportation Corps' capability."

LIFE SUPPORT

Mental competence at a depth of 450 feet breathing normal air is the objective of a study now underway at the Experimental Diving Unit at the Naval Weapons Plant, Washington, D.C. Navy Chief Hospitalman John R. Vail turned in an encouraging performance during a recent 10-minute nitrogen narcosis test under 200 psi pressure.

A highly efficient non-boiling seawater evaporator has been developed and successfully demonstrated by General Electric Company. System consists of two concentric vertical tubes and a unique wiper assembly whose blades spread salt water on the inner surface of the inside tube in a film scarcely one-thousandths of an inch thick. Steam heat transferred through the walls of the inside tube causes the salt water to evaporate without bubbling. BuShips and Interior Department's Office of Saline Water funded the project.

ASW SURFACE CRAFT

Contract for a 38-foot jet propelled boat has been let by Boeing Airplane Company to Blanchard Boat Co., Seattle, Wash. To be powered by a J-33 turbo-jet engine, craft will be used as an inside-out water tunnel for studying high-velocity hydrodynamics. Planing "skis" will reduce drag and dampen fishtailing. Twin rudders can be diverged as brakes. Experimental shapes will be suspended between twin hulls.

Contract for air conditioning Grumman Aircraft Engineering Corp.'s turbine-powered hydrofoil has been placed with Garrett Corp.'s AiResearch Manufacturing Co. div. in Los Angeles. AiResearch already has a contract to provide Grumman hydrofoil with gas turbine auxilliary power.

Maritime Administration is pulling universities into ship-design programs, as fast as contracts can be signed and money made available. Latest moves: Four contracts with as many universities, to study means of designing more productive and efficient ships; and a new contract (with Stanford Research Institute) for further studies of potentials of hydrofoil craft.

HYDRODYNAMICS

Underwater researchers are borrowing a page from early aircraft designers' books—but they'll study a porpoise, instead of birds—at the Naval Ordnance Test Station at China Lake, Calif. You've probably read

newspaper accounts of "Notty", the porpoise, who has been inclined to be a little uncooperative lately.

What interests NOTS scientists is not the porpoise's intelligence (rated highest among sea denizens) but four very important aspects of his normal performance: 1) the animal's apparent ability to control the boundary layer while swimming; 2) his use of body and fins in the manner of an oscillating foil—a sort of submerged hydrofoil; 3) his ability to produce sound frequencies that can spot obstacles, food, or be used for communication; 4) the ability to achieve extremely fast acceleration. A parallel study is under way at the University of Washington (on salmon) to check further on the effect of undulations on speed and direction.

OCEANOGRAPHY

If you hear of a Navy vehicle called "RUM", you'll know it's not the traditional seagoing ration, but rather Remote Underwater Manipulator—a vehicle for exploring the ocean bottom. Equipped with four television "eyes" (fitted with RCA's small vidicon tubes, more normally used to telecast movie films) the vehicle can crawl along the ocean floor at about 3 miles per hour, and can remain underwater for several months at a time (with remote controls from the surface).

An all-transistorized position-determining buoy has been developed by Hastings Raydist, Inc. Designed for salvage or hydrography purposes, the Raydist buoy employs heterodyne phase comparison rather than pulses to automatically supply range to surface or airborne craft within 15 miles. Dry cell battery pack provides a life up to 30 hours. Whole system weighs less than 45 lbs.

ELECTRONICS

Strictly airborne now but with promise of undersea applications, FAA has recently demonstrated a 3-D radar display system.

Much lighter inertial guidance stable platform for advanced models of POLARIS missile has been developed by GE's Ordnance Dept. and Massachusetts Institute of Technology. Important contribution to weight reduction is recently discovered fact that in-flight vibration is not as severe as previously estimated.

Contract for 10 stabilization data computers for nuclear powered submarines has been placed with Burroughs Corp.

SOUND

A new low frequency sweeping oscillator has been developed by Kay Electric Co. Sona-Sweep Model M's sweep center frequency is adjustable between 20 cps and 200 kc, and has an accuracy limited only by the counter used with it.

License to produce lead zirconate-lead titanate piezoelectric elements has been granted to Acoustica Associates, Inc., by Clevite Corp.

The Acoustical Society of America will hold its 61st meeting at the Bellevue Stratford Hotel, Phila., Pa., on May 10-13. There will be special sessions with 27 papers devoted entirely to underwater acoustics.

POWER

New sea-water battery with "more uniform performance, higher voltage per given current, and a flatter operating voltage" is being shown by Yardney Electric Corp. at the IRE show in New York. Production is scheduled within the year.

STRUCTURES, MATERIALS

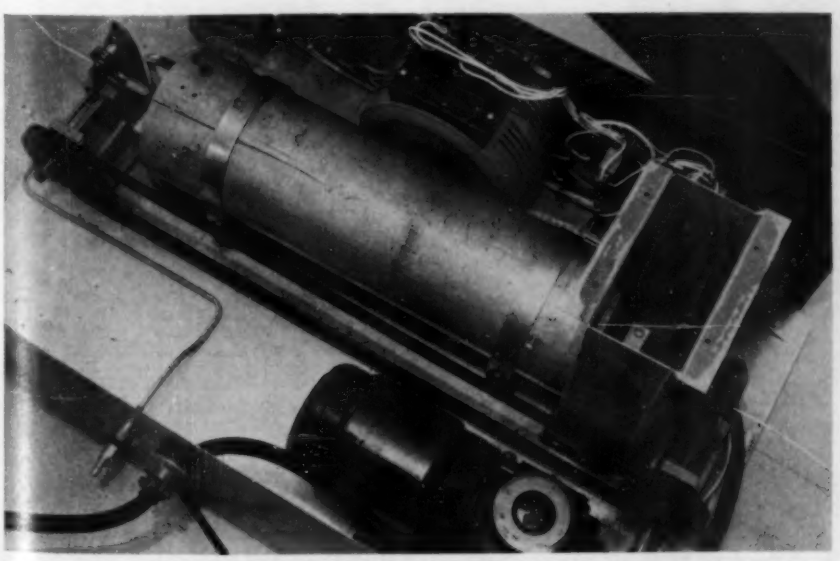
Garan-finished glass cloth has come out best in a five-year seawater immersion test of five different glass-polyester resin materials. For details order PB 161 912 from Office of Technical Services, Commerce Department, Washington 25, D.C. Price $1.25.

LEGISLATION

A bill for oceanographic research by the U.S. Coast Guard has been introduced by Senator Warren G. Magnuson.

MANAGEMENT

A one week course in the PERT (Program Evaluation and Review Technique) management system, as used with POLARIS, has been scheduled by Operations Research, Inc., Santa Monica, Calif., to start April 3. Navy contractors who aren't familiar with the PERT system should get to know it. It is spreading throughout Navy weapons system management.



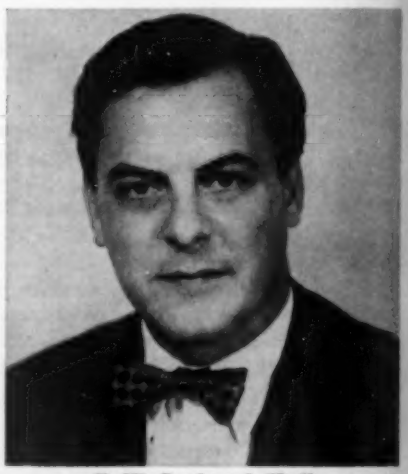
Sintering oven designed by The Martin Company for permanently marking Teflon insulated wire, provides encoding for high temperature environments.

Light-weight, high power beacon developed by Hastings Raydist, Inc.

E. W. Seabrook Hull Joins Sheffield Publishing Co., Inc.

E. W. Seabrook Hull has joined Sheffield as Editorial Director of GSE and Underwater Engineering magazines. Mr. Hull, who has several years experience in the trade journal field, comes to Sheffield from Missile Design and Development Magazine where he was Special Features Editor. His recent editorial activities also include the writing of a special underwater ordnance column for Ordnance Magazine.

A former Associate Editor of Missiles and Rockets Magazine, Mr. Hull co-authored the book *Rocket to the Moon*. He was for two years Bureau Chief, McGraw-Hill World News — London, and United Kingdom Manager of McGraw-Hill Overseas Business Services. Prior to the foreign assignment, Mr. Hull was Washington Correspondent of McGraw-Hill News Bureau where he covered all aspects connected with USA's defense programs.



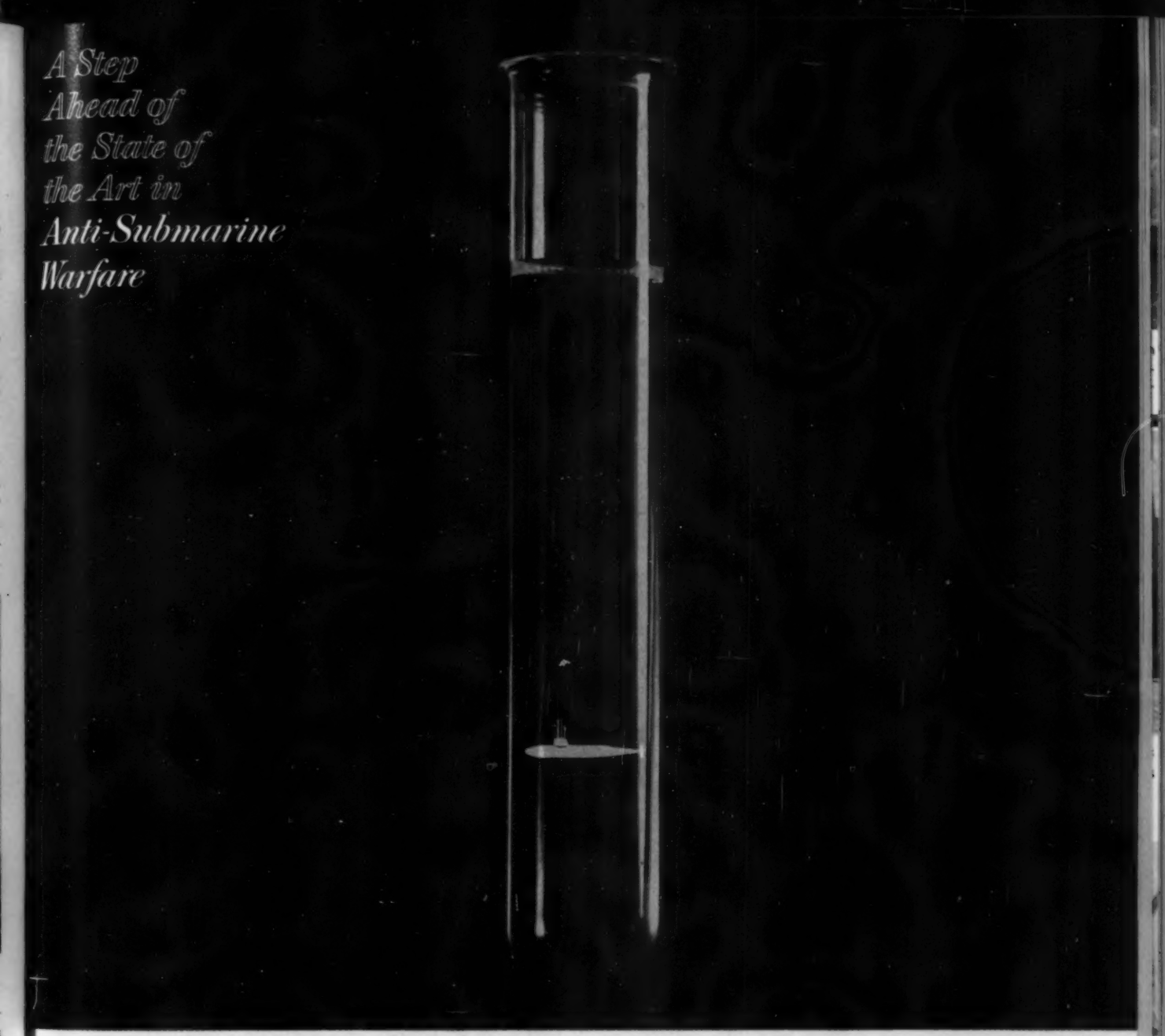
E. W. Seabrook Hull

With Whaley Eaton Service, Mr. Hull was Editor of that company's *Foreign Letter*, covering foreign economic, political, financial, business, and technical developments for top U. S. management personnel.

Mr. Hull was educated in physics at Union College, Schenectady, N.Y. During World War II, he saw service as a Marine Corps pilot.

Mr. Hull holds membership in the following organizations: Royal Aero Club — London; the Press Club — London; The American Rocket Society; (Fellow of) the British Interplanetary Society; The Army and Navy Club — Washington; The National Press Club; and the Rocket City Astronomical Society — Huntsville, Alabama.★

A Step Ahead of the State of the Art in Anti-Submarine Warfare



400,000-gallon test tube for ASW research

ASW research at General Dynamics/Electronics gets a powerful lift from a giant research tool . . . the largest privately-owned indoor facility for underwater acoustic testing. It's a circular, open-topped test tank, 48 feet across, 30 feet deep, complete with automatic test instrumentation for all types of acoustic measurements.

Overhead equipment, capable of hefting a 2½-ton transducer, can position a target or a transducer anywhere in the tank. Measuring equipment can be placed on the surface, to study the air-water interface as part of an acoustic transmission path. Underwater lights and a viewing port at the fifteen-foot level permit direct observation or photography.

Designed specifically for great flexibility, the tank is the finest ASW research tool in the industry. It provides General Dynamics/Electronics with a commanding capability in the exhaustive testing procedures needed to develop and test advanced Sonar equipment.

Overall, General Dynamics/Electronics has a wide range of experience in the development and production of ASW equipment. Included in this background are the AN/SSQ-38 (XN-2) sonobuoy now under development, the AN/ARR-52 transistorized, high-density sonobuoy receiver now scheduled for production, and the AN/UQS-1D mine-hunting sonar, on which deliveries are now being completed.

For further information about ASW research and development at General Dynamics/Electronics, write for the illuminating facts.

Engineers and scientists interested in challenging opportunities are invited to send résumés to Manager, Engineering Employment.

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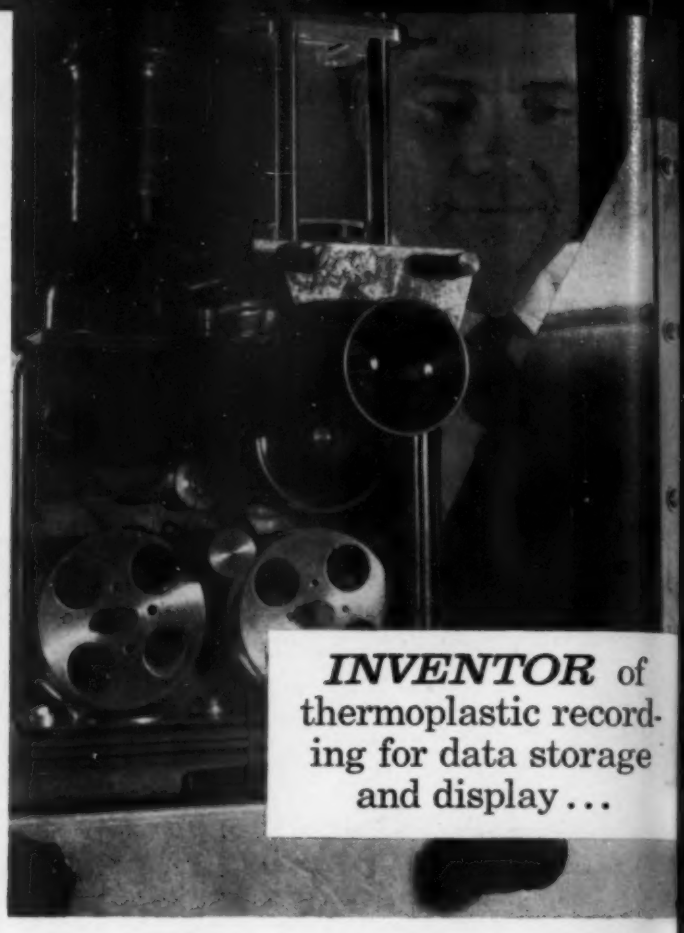
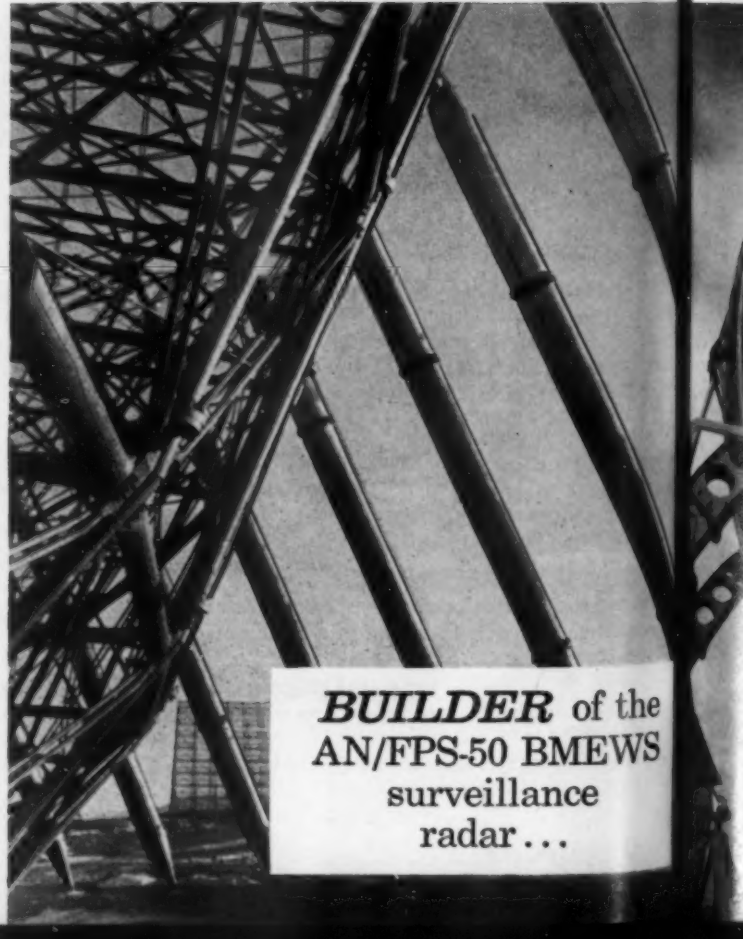
INVESTIGATOR into new methods of sonar signal processing . . .



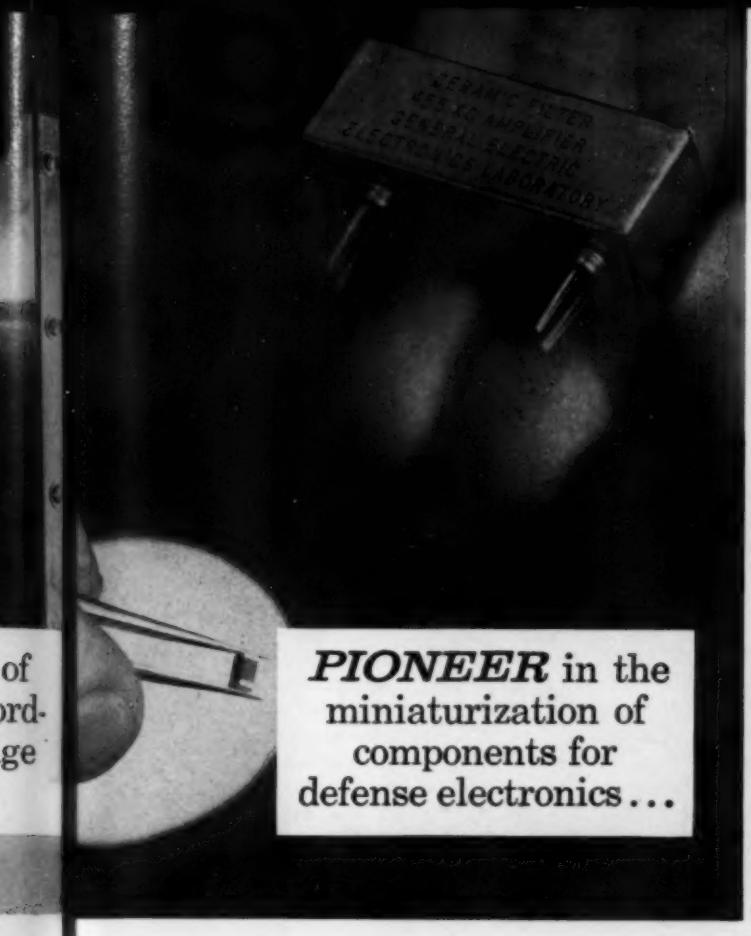
INVENTOR of thermoplastic recording for data storage and display . . .

The Many

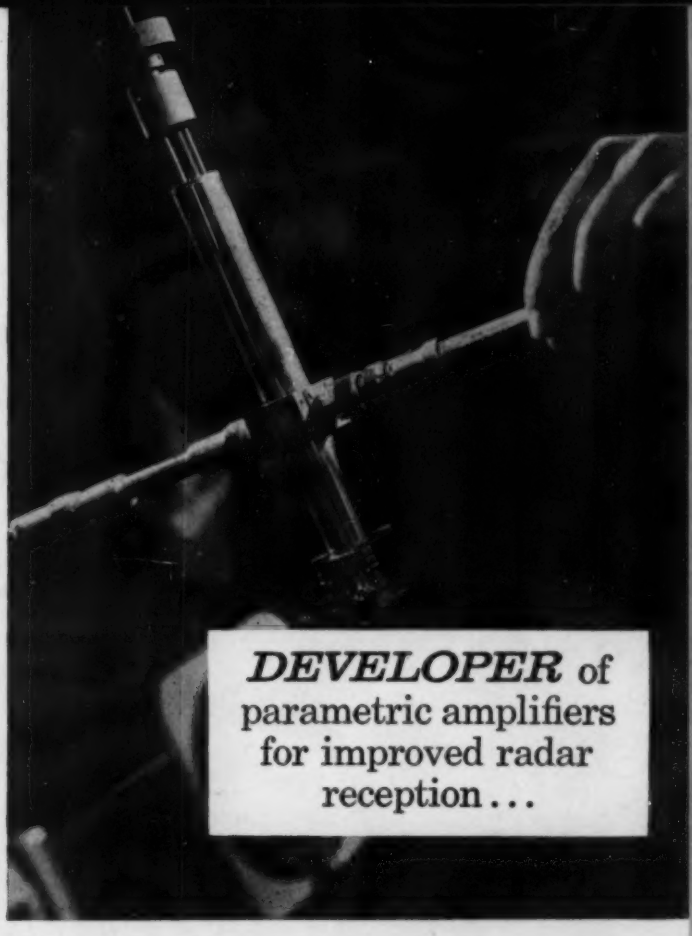
CONSTRUCTOR of the first fully automatic 3-D radar data processor . . .



BUILDER of the AN/FPS-50 BMEWS surveillance radar . . .

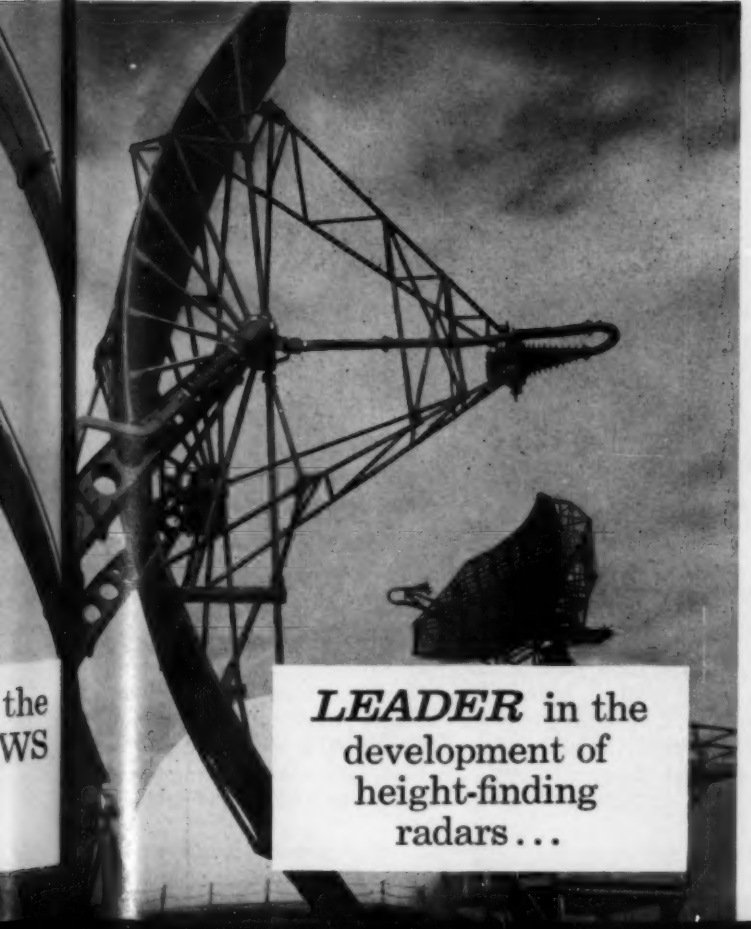


PIONEER in the miniaturization of components for defense electronics...



DEVELOPER of parametric amplifiers for improved radar reception...

Roles of HMED*



LEADER in the development of height-finding radars...

*General Electric's Heavy Military Electronics Department

Seven examples of the roles that General Electric's Heavy Military Electronics Department is playing in contributing to U.S. defense strength are illustrated here. Of course, the full spectrum of HMED activities is much broader. It includes work in radar, sonar, missile guidance and control, and computers; in data handling, communications, counter measures, and ground warfare; in air defense, missile defense, and product service. 176-10

Progress Is Our Most Important Product

GENERAL ELECTRIC

DEFENSE ELECTRONICS DIVISION, SYRACUSE, N. Y.

Circle Reply Card No. 7

capital report ★★★★★½

By E. E. Halmos

Streamlining of Defense Department activities — rather than a complete overhaul that was recommended by the Symington Committee — is already started. That doesn't mean that there'll be no Congressional tries to revamp DOD, but it is becoming obvious — as predicted in these columns — that the Kennedy Administration isn't buying a complete upset this year.

* * *

Probably most important change for contractors is the consolidation of the offices of Assistant Secretary for Properties and Installations, and Assistant Secretary for Supply and Logistics into a new office: Assistant Secretary for Installations and Logistics.

* * *

Background of Thomas Morris, named as Assistant Secretary for Installations and Logistics gives a broad hint as to its direction. Morris, a management consultant of considerable standing, served most recently in the Bureau of the Budget, was consultant to both Hoover Commissions, and served in the Office of the Secretary of Defense on management problems. During World War II was a member of the Navy's management engineering staff. His new office will reduce from 15 to one the number of people reporting on procurement directly to Sec. of Defense McNamara, and presages streamlining of procurement policies and directives in all three military departments.

* * *

Speaking of procurement practices, look for a lot of furor — if not actual legislation — in three areas: Negotiated contracts; employment of former government purchasing officials by private contractors; and the apparent concentration of defense contracts on the West Coast. All of these are hardy perennials, but they have considerably more steam behind them this session of Congress.

* * *

The question of negotiated contracts would be attacked by the device of insisting upon review of such contracts by the General Accounting Office (which is responsible to Congress, not the President), under a bill recently introduced (S 769). Military departments would be required to support negotiated procurement with detailed documentation, in order to pass GAO's scrutiny.

* * *

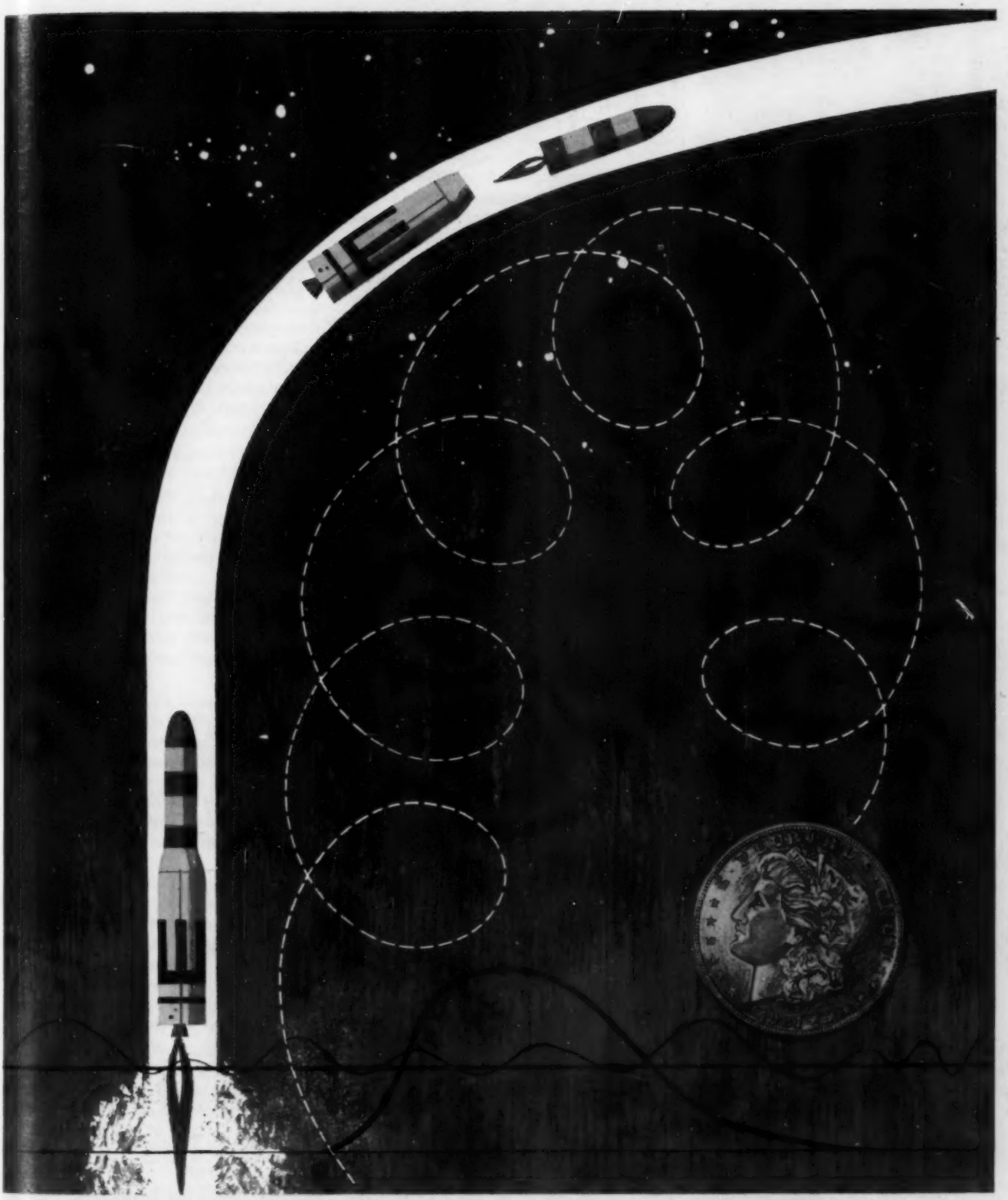
Employment of former government purchasing personnel (broadened now to cover civilian as well as military agencies) would be barred for two years after the individual leaving government service, under another bill — if prospective employers had any dealings with the employees during their time with the government.

* * *

As to geographical distribution of contracts, here's what's bothering Eastern members of Congress: According to Maryland's Senator Butler, in Fiscal Year 1959, 28.4 per cent of all defense prime contracts went to firms on the West Coast, in FY 1960, 27 per cent. "Let us be sure that the bright glitter of former military brass . . . doesn't blind us to the realities," said Butler, who wants Congress to investigate the situation. He's concerned, of course, with unemployment in Maryland and other Eastern defense industry centers.

* * *

Another perennial — with a good chance of passage this time — is Senator Magnuson's Marine Sciences Program bill (S 901), which would establish a 10-year program of oceanographic research and surveys, promote commerce and navigation, and have a very strong tie-in with the defense program. It calls for a total of $600 million over the 10-year period, and follows very closely on recommendations by the National Academy of Sciences-National Research Council, two years ago. The money would be spent by various arms of the government on ships, laboratories, exploration, and research aimed at learning more about the oceans and what's in them.



BUT, MONSIEUR BERTRAND, OUR COINS HAVE MEMORIES!

You said, "A coin has neither a memory nor a conscience." The reliability of our inertial guidance systems depends on their having both. Thus our reliability engineers must go beyond your venerable formulae in developing dependable guidance packages for missiles like Titan.

If the application of existing theory into usable reality challenges you, and if you have a BS, MS or PhD in EE, ME, Physics or Math, please contact Mr. F. M. Allen, Director of Scientific and Professional Employment, 7929 S. Howell, Milwaukee 1, Wisconsin.

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Circle Reply Card No. 9

LETTERS TO THE EDITOR

To The Editor:

The warning and opinions expressed in your editorial (page 6) of *Underwater Engineering* January 1961 are appreciated. The newly organized professional group on underwater technology in the American Society of Mechanical Engineers will make a significant contribution to underwater development and engineering.

The purpose and motivation of this group has been reviewed by over 150 mechanical engineers involved in underwater engineering work. These men are faced with the same questions which your periodical must have faced with when first considering the need for its existence.

Our first activity will be a symposium during the week of November 26, 1961, to describe and define the future of underwater technology. The participants in this symposium include persons who are leaders in this field.

The following persons are serving on the Executive Committee: **Dr. John Craven,** Chief Scientist, Special Projects Office, Bureau of Naval Weapons; **Dr. H. Norman Abramson,** Head of the Mechanical Sciences Section of Southwest Research Institute; **Commander Arnold Medbury,** Machinery Design Branch, Bureau of Ships; **Dr. George F. Wislicenus,** Ordnance Research Laboratory, and myself.

Richard Neuendorffer, Chairman
Professional Group on Underwater Technology ASME

We are watching ASME's undersea technology group with keen interest, and look forward to the November meeting. Further details on the symposium will be published in a later issue of this magazine. —*Ed.*

To The Editor:

The January 1961 issue of Underwater Engineering states in "Engineering Notes" on page 18 that Captain Jacques-Ives Cousteau's Diving Saucer is a "diving bell" with "waving arms which are used to house water-squirting nozzles for movement and control underwater." Reference to Captain Cousteau's article on the DS in the April 1960 National Geographic might have spared you this odd description of the proven and versatile Continental Shelf vehicle.

The DS is not a bell, but a submarine with a pressure hull. Her hydrojets revolve vertically on a 360-degree traverse, giving all possibilities of navigation forward and astern. Laterial manoeuvre is afforded by suppressing the flow in one of the jet pipes. Combining the two systems produces complete three-dimensional manoeuverability.

James Dugan
237 Pine Street
Philadelphia, Penn.

UE stands corrected. Our thanks to Mr. Dugan. —*Ed.*

To The Editor:

Our attention has been called to your column "Shipways" (page 10) in the January 1961 issue of *Underwater Engineering* in which the following statement occurs: "Despite Navy's economy measures, the historical fact remains that work done in government industries is more costly than that performed in private industries."

That is a sweeping generalization which it would be difficult if not impossible to substantiate statistically because so many factors, some tangible and many of them intangible, enter into the picture. Certainly, it is not a sound commentary on this issue as it refers to naval construction.

Take the case of the *Forrestal* class super-carrier to which you specifically refer. The private yard bid was not $40,000,000 less than the estimate for construction by a Government-owned yard but $30,000,000. That is a considerable reduction in the indicated spread.

Your column states that the public has a "right to demand" that "a fair portion" of all the Navy's shipyard work "be done by private industry." The fact is that of 80 vessels now under construction, 55 are being built in privately-owned yards.

Here again, however, the matter of relative cost must be considered with special reference to the fact that the private yards are using hundreds of millions of dollars worth of equipment and installations bought and paid for by the Government — by the American citizens who paid the taxes. That public investment in private yards surely must be taken into account if one is to fairly appraise relative costs.

The Government has made that investment pretty much in the na-

ture of a calculated subsidy to keep a private shipbuilding industry in being. But to take the position that an even greater volume of such work should be contracted out, idling Government yards and highly skilled craftsmen employed by the Government, can not be justified on any ground, whether of cost, convenience, or the highest interests of national security.

As a matter of fact, the contracting-out of work historically done by Government yards already has reached a point at which both the Congress and the Executive Branch should call a halt in the national interest.

The policy that work should be divided between Government and private yards, so that both can serve the Nation's defense needs, appears to be a settled one. It is seriously disquieting, however, to find that efforts to divert an ever-increasing volume of that work to private yards are being pushed to a degree indicated by your column.

We do not believe that such a policy serves the country's highest defense needs nor that it can be justified on the ground of so-called economy.

Vaux Owen, President
National Federation of
Federal Employees
Washington, D.C.

We are sure many of our readers have their own pet theories regarding this important question. UE hereby invites letters giving these theories for publication. In the meantime, thanks to President Owen for his interest. —*Ed.*

To The Editor:

We enjoyed seeing the item in your January issue (Underwater Sidelights, page 4) on PROJECT MOHOLE. You pointed out that "methods of mooring the barge in 12,000 ft of water are of particular interest."

We had the privilege of supplying National Science Foundation four of our heavy-duty right angle propulsion and steering units for Propelling and positioning Global Marine's drilling vessel *Cuss I.*

There are two "Harbormasters" mounted aft at each corner and two forward, each powered by a 200 hp. diesel engine turning a 5-ft propeller. Distance between engine and propeller center line is 16 ft with a vertical stem rotating through an endless 360 degrees for direct thrust steering.

Steering and throttle controls are centrally located in the pilot house. The operator can alter the thrust and direction of propulsion independently or in combination as required, giving thrust and motion in any desired direction. The ship's position will be determined relative to a ring of four or five buoys anchored to the bottom and held several hundred feet below the surface by taut lines. The design of the buoys is expected to minimize the offset caused by ocean currents.

The buoys will be equipped with sonar transponders, or "pingers", which respond to sound waves sent through the water by the ship in the middle of the circle. Electronic equipment on the ship will translate the signals received into distance, and present this to the pilot so that he can maintain position in relation to the buoys. The pilot will regulate the amount and direction of thrust of the "Harbormaster" through a central control to maintain the ship's position over the hole.

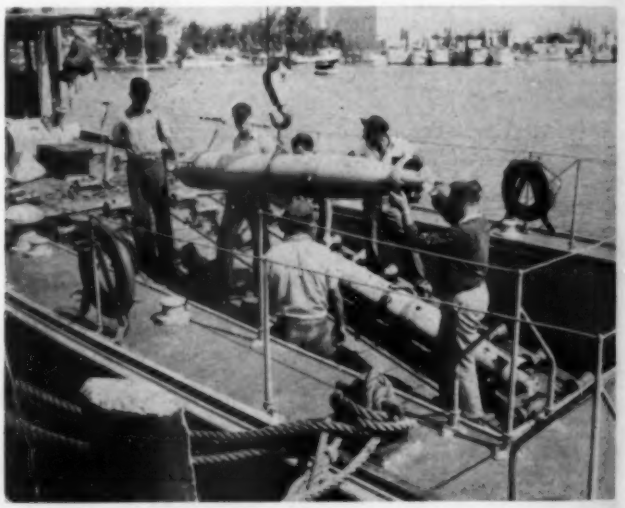
R. O. Snowman
Murray & Tregurtha Inc.
Quincy, Mass.

Thanks for bringing the above to our attention. —*Ed.*

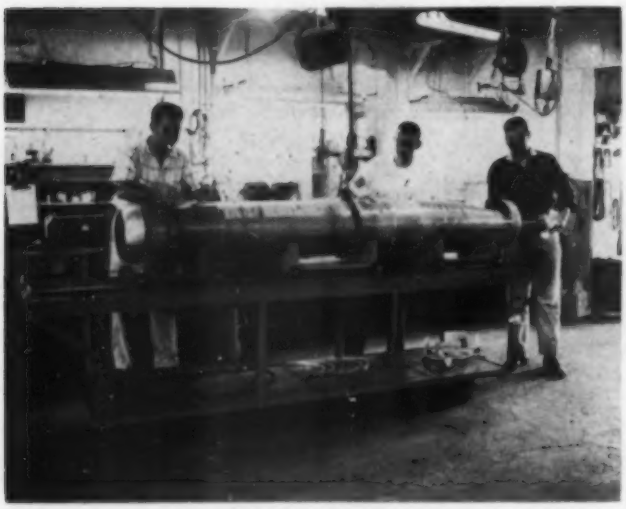
MARK 44 TORPEDO EVALUATION

The Mark 44 acoustic homing torpedo is the U.S. Navy's latest operational torpedo. It can be ship-fired by conventional methods, air-dropped, or ASROC-boosted over 18,000 yds. General Electric's Ordnance Dept., Mark 44 manufacturer, operates a Field Test Station for the Navy at Key West where these shots were taken. Mark 44 has speed and depth needed to kill latest nuclear subs.

Mark 44 torpedo's most sophisticated application: Here ASROC carrying acoustic torpedo streaks away from USS Norfolk on test flight.



Recovered test Mark 44's are returned to laboratory for study. Note cage protecting sensitive acoustic head during shore handling.



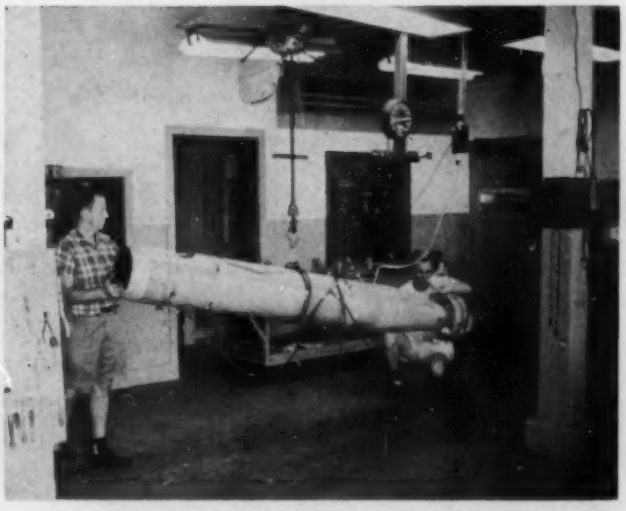
Here propeller shaft is removed; clamps joining afterbody and battery section are released; hand-hole cover comes off exercise head.

Mark 44 sea-water battery is expendable, but those from test torpedoes are returned to the factory where 95 per cent of unit is reclaimed.

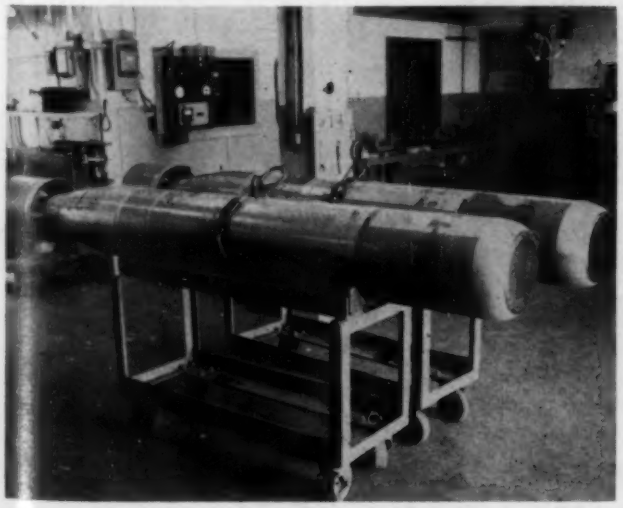
After each test run electrical and electronic sections are thoroughly checked out to insure proper performance during the next run.

Sea-water batteries have unlimited shelf life if they are kept dry. Here, fresh units are being readied for installation in torpedo.

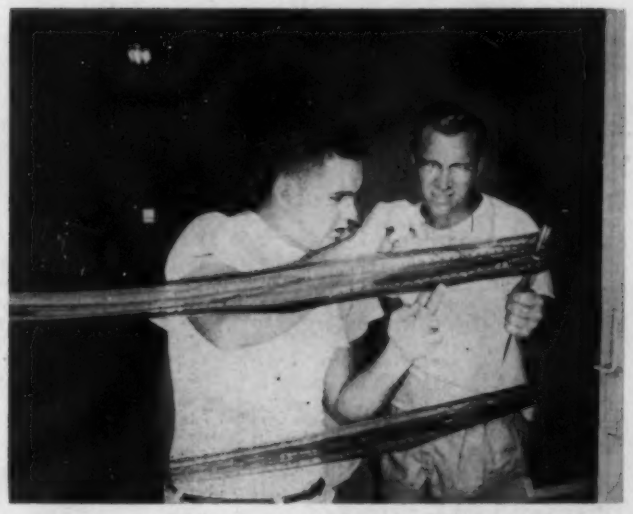
Pressure calibration is given to the exercise head after instruments and recorders have been checked out and before reassembly.



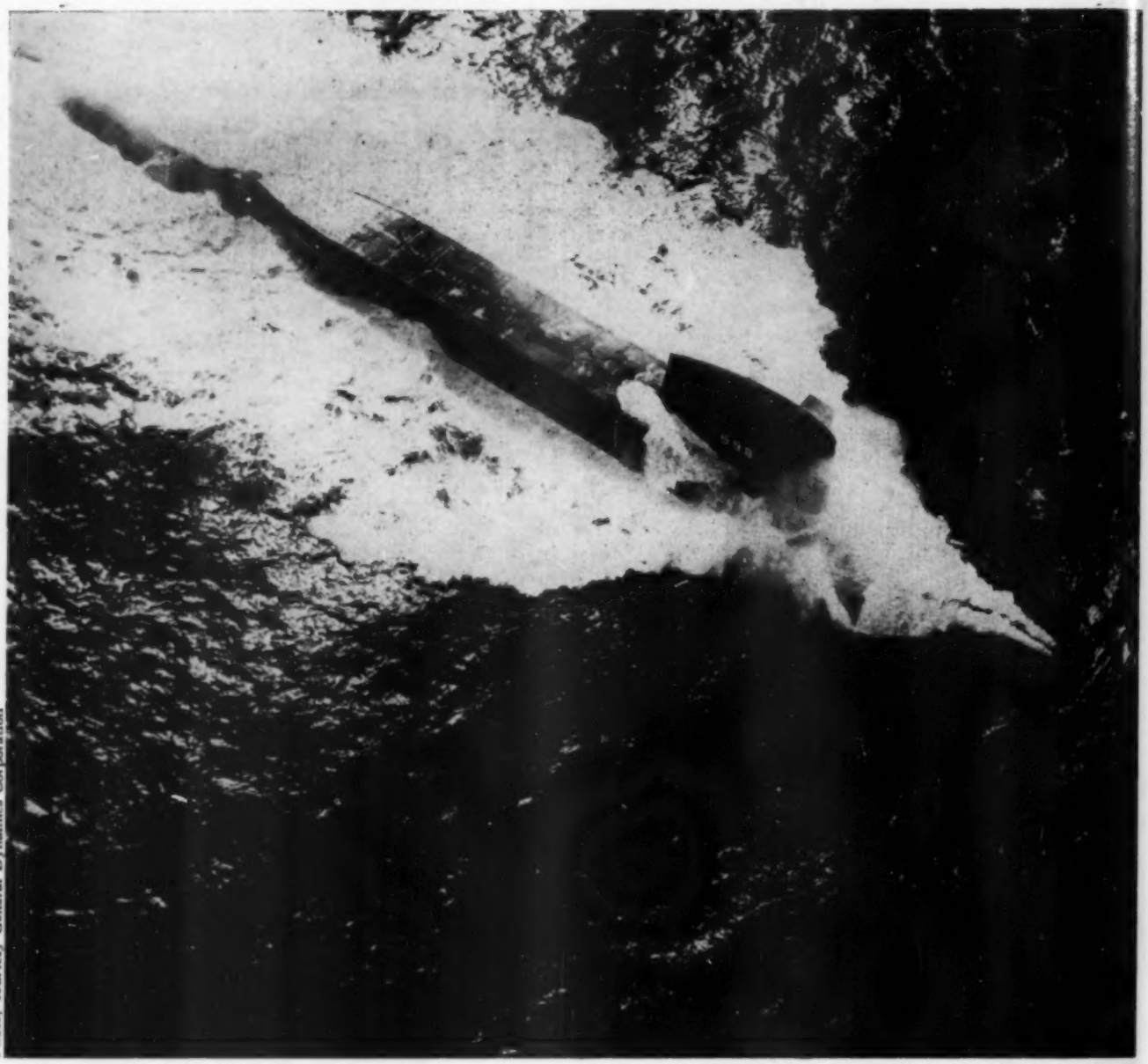
Reassembled Mark 44 gets thorough system checkout, and control rudders are calibrated. A light tap on acoustic head deflects rudders.



A ter complete system checkout, all parts are b ttoned up; propeller guard slipped over sh oud ring; Mark 44 is ready for another run.



Test film has recorded 14 different vital bits of information during run—roll, pitch speed, depth, input and output sound, and range.



Photo, courtesy General Dynamics Corporation

MIGHT on the MAIN

EDO CONGRATULATES THE U.S. NAVY on its mighty deterrent fleet, symbolized by the *U.S.S. George Washington* on operational patrol – fast, far-ranging, Polaris-armed. Edo is proud to share as prime contractor in the Navy's Polaris program by designing and building systems that are being tested and proved daily as the *George Washington* and her FBM sister ships prowl their protective missions . . . "a fleet that will never attack first, but possess sufficient powers of retaliation, concealed beneath the sea, to discourage any aggressor from launching an attack upon our security."*

President John F. Kennedy's State of the Union message, January 30, 1961

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Hear this . . . Somewhere under the seven seas, part of the Navy's nuclear deterrent force is on station. Aboard the Polaris submarine George Washington command communications equipment stands ready for operation. This equipment was developed by Avco. Highly skilled scientists and engineers of Avco's new Undersea Projects Office are working on antisubmarine warfare problems and research on related underwater phenomena.

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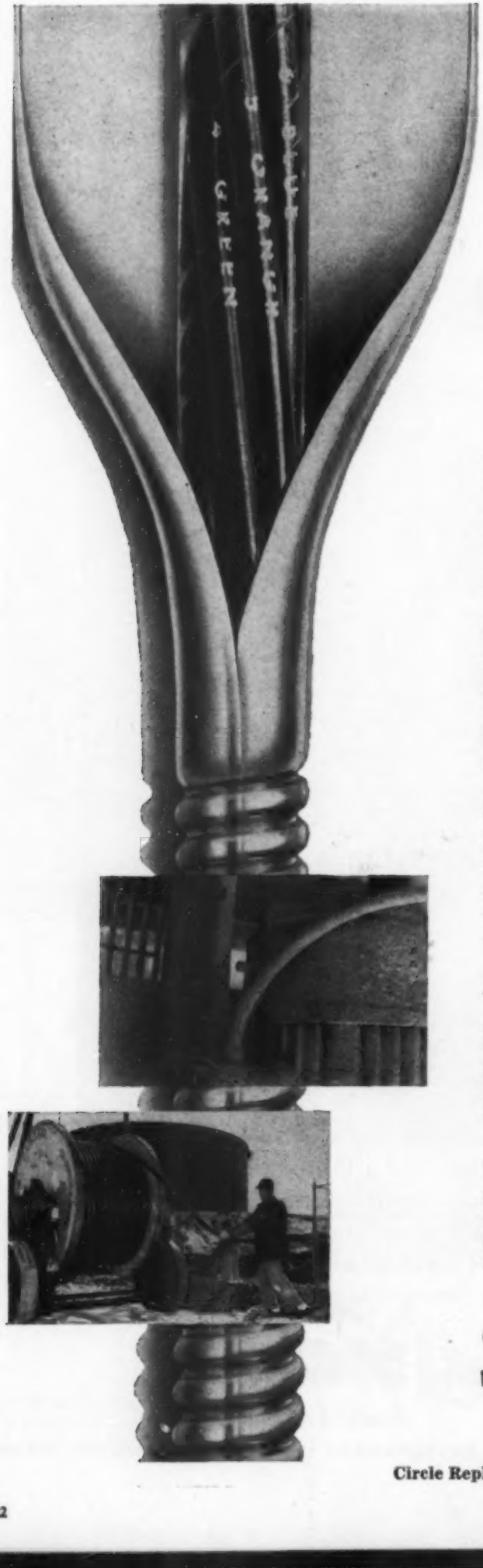

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Conduit life in this company's calcium chloride reclamation building was only 6 to 9 months. The conduit was replaced with a C-L-X cable system which — after two years of operation, shows no signs of deterioration.

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Circle Reply Card No. 14

underwater engineering

Vol. 2, No. 2 March/April, 1961

underwater fire control

gear must be lighter, more compact and not preempt command decisions

By Seabrook Hull

Two requirements make underwater fire control unique:

Final command judgement must remain with the human skipper.

Need for lightness, compactness and reliability approaches aircraft and space requirements.

The essence of the complexity of underwater fire control is water itself. If the oceans constituted a nice stable predictable environment like, for example, air or space it would be a simple case of precise automatic programming. Sit back and pray for reliability.

But water is different. When you "see" a target over there, it probably isn't really over "there" at all —depending on the time of day or year. your depth, latitude, or longitude or whatever—and, in fact, may not really be a target at all.

The underwater realm is so complex and so variable that extremely sophisticated systems and equipments are required to remember all the variables, correlate all the observations, and discriminate between all the possibilities.

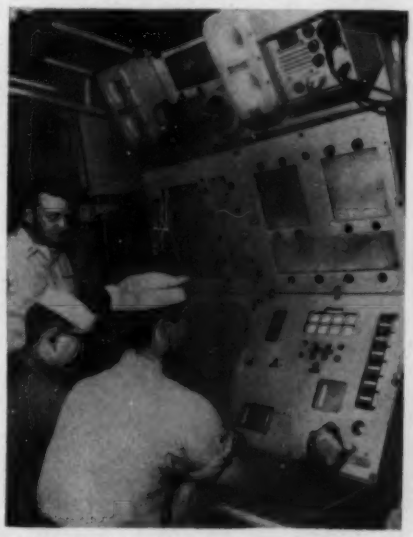
The first problems of underwater fire control are: Determining if there is a target at all; and then trying to second guess where it is, what it's doing, and how fast it's going.

After that, problems of calculating weapon-launching vessel speed and direction of travel, same for target, and interrelating these with weapon capabilities is academic and much the same as for an anti-aircraft gun, anti-tank fire control, or half-frozen duck hunter.

But somewhere in the middle area lies a requirement for underwater fire control that separates it off and apart from most Naval fire control systems: Knowledge of the environment is so limited, the variety and aspects of targets so variable and the elements of decision so unpredictable that there must be a gap in the automatic programming of the solution of a tactical situation when a spur-of-the-moment *human* decision is a must.

Many are the costly and extensively thought-out proposals submitted to the Navy that would take complete command of any tactical situation in which a submarine might conceivably find itself. All sonar and anomoly detection, ranging, and bearing signals would be acquired and processed. Nature of the threat and its program of future action were to be anticipated. The total tactical situation would be analyzed, and detailed decisions as to active counter action and/or assault would be made and executed—all automatically. And the skipper of the vessel? Well, we guess he would man the reliability tube tester.

Anyhow, such proposals haven't made the grade. On surface ships, yes. And also on aircraft, this approach of the fully automated mission programmer is meeting with increasing favor, both philosophically and in fact. However, in undersea craft it is a preemption of command prerogative that for the moment at least is not about to be tolerated.



ASROC Mark 38 Attack Console manufactured by Librascope Division, General Precision, Inc.

Purposes of tactical undersea fire control are to acquire and analyze recorded and measured data and to present them to the fire control officer in the most readily readable manner; and—once the fire control officer has decided what to do and when—to conduct whatever aiming and guidance computations are necessary to assure best chances of mission success.

Light weight and compactness are a universal requirement of any equipment going into submersibles today. The hulls of deep-diving high-speed submarines are getting heavier and heavier as depth and maneuverability become greater. Buoyant weight is becoming a serious problem. Space has always been a problem.

More weapons than ever before are being crowded into undersea craft, and the electronic equipment to provide precise underwater navigation and fire control is constantly growing in volume. So is all the equipment of propulsion, life support, etc.

You see the trend in the progress from the Mark 101 torpedo fire control system used in the older conventional and nuclear submarines to the Mark 112 now in use. Both do the same job in approximately the same manner and in approximately the same time. However, the Mark 112 has been completely transistorized — with major savings in weight and space.

New compact high-precision inertial gyro for SINS, heart of POLARIS submarine's navigation system, is manufactured by Minneapolis-Honeywell Regulator Company.

fire control

POLARIS MARK 80

ASROC Mark 111

The POLARIS system, on a much larger scale is similar. The decision of when to fire how many missiles is a human decision, transmitted to the submarine while it is cruising deeply submerged. The POLARIS fire control system maintains a constant ready-alert input of information into the missile's inertial guidance system with respect to precise relative positions of launching submarine and target.

For the most part, target data is plugged into each missile on a more or less permanent basis during each patrol. Each missile, in effect, has a city's name on it. This name can only be changed by substituting a different target programmer module. It is, thus, the primary job of the POLARIS fire control system to inform the missile of a constantly changing launch site. A measure of its effectiveness is the fact that the present operational system enables POLARIS missiles to be launched at a rate of one a minute.

Designated the Mark 80, this system typifies the trend to lightness and compactness. It is the Navy's first fire control system to be completely transistorized. It contains more than 17,000 transistors, over 1,000 digital boards, 39,000 diodes, 40,000 circuits, and a quarter of a million circuit terminations. It utilizes both analog and digital computers and contains electronic units for converting data from one form to another. It was developed by the General Electric Ordnance Dept., Pittsfield, Mass.

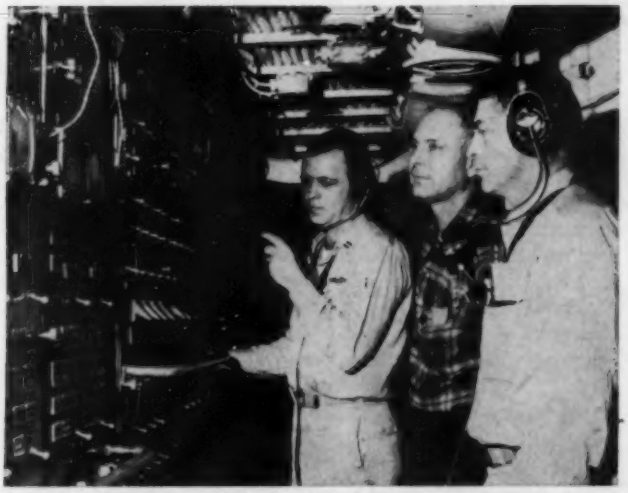
The computers used in the fire control system incorporate the most modern electronic features. Transistorized plug-in type wiring boards help to affect equipment miniaturization, and advanced packaging techniques have made the system sufficiently compact to fit the allotted space within the submarine.

It is rugged, designed to operate under all conditions of sea and weather. It will continuously pro-

GE Ordnance Dept. make adjustments to POLARIS Mark 80 fire control system units during evaluation checkout.

Master console for display of readiness status and monitoring POLARIS countdown on board FBM submarines during check.

These POLARIS fire-control elements are in the block-house at Cape Canaveral, where they are used in missile tests.



Aboard the FBM USS THEODORE ROOSEVELT, Lockheed Missiles & Space Div. and Navy personnel observe missile launch control panel.

vide accurate information to the missile guidance system despite sea conditions of roll, pitch, yaw, etc.

The Mark 80 contains a battery of computers that constitute its "brain". These receive from SINS, information on ship's position, direction of travel, speed, and other velocities resulting from motion of the submarine. Data on the location of the designated target is then fed to the computers. The intelligence derived through the computations is fed to missile inertial guidance systems. The fire control system makes continuous corrections to the guidance intelligence. During the countdown, fire control display consoles tell the commanding officer and fire control officer the status at any given moment and indicate when all is in readiness for firing. Mark 80 fire control systems are being installed in the first nine FBM submarines.

The Mark 80 fire control system is now operational. The Ordnance Department is now engaged in the design and fabrication of the Mark 84, an advanced fire control system, for the next generation of Polaris-firing submarines.

This new system will provide the Navy's Fleet Ballistic Missile Weapon System with improved operational capability enabling more rapid launching sequence. It makes extensive use of new digital computing techniques and will be more automatic than its predecessor. A new concept in packaging will make the MK 84 easier to operate and maintain. First installation of the advanced fire control system will be aboard the USS LAFAYETTE (SSBN-616).

The ASROC Mark 111 Underwater Battery Fire Control System is another excellent example of the trend of modern Navy fire control technology. This system and its Mark 38 Attack Console (made by Librascope div., General Precision, Inc.) automatically calculate target course, speed, and horizontal range, issue train and elevation orders to the launcher, and thrust cut-off and airframe separation orders to the missile.

The Mark 111 is capable of handling fire control problems of the Mark 2 ASROC, Mark 44 torpedo, and the Mark 1 depth charge. In this surface-ship mounted system, however, as in the case of submarine equipment, weapons control personnel (fire controller and ship's captain) play an important part in planning actual attack on an underwater enemy.

It seems quite probable that this critical element — the human element — of fire control with respect to underwater or multiple environment situations will remain until such time as the underseas environment becomes as familiar and predictable as the air itself. And for now and some time to come it would seem that the only thing predictable about the ocean depths is their completely reliable unpredictability.★

Opportunities in ASW

By Capt. T. D. McGrath, USN (Ret.)

The emphasis accorded antisubmarine warfare by major defense-industry companies in national advertising, coupled with the importance attached to this branch of warfare by the National Security Industrial Association, evidence American industry's appreciation of this critical segment of our defense. Because ASW is a most complex form of warfare, perspective is difficult to attain. Industry's attention has tended to be concentrated in the major and most obvious problem areas: detection, classification, localization, and attack. The result has been developmental proposals for major equipments and complex weapon systems which can only be attempted by the largest companies.

ASW, however, encompasses many supporting areas where needed equipment can be developed and supplied by smaller companies. Such equipment in some cases will be needed in quantity and on a continuing basis, giving promise of profit from a production point of view as well as from development. Such equipment needs to be simple, rugged, relatively inexpensive and, where possible, expendable. Fertile areas for study and exploitation include: training, oceanographic applications, countermeasures, mines, control, and evaluation.

Training—Navy's operating forces recognize training requirements as a problem of immediate importance and concede that these ought to be incorporated in all new equipment design. In practice, there is a considerable lag between equipment production and the provision of means to assure personnel capable of operation, maintenance, upkeep, and repair. Tactical training in multiple applications lags even more. Operational training, unit and group, requires a target and realistic environmental conditions in most instances. Submarine target time is always limited and simulation is the obvious alternative. Realistic simulation often results in trainers and devices almost as expensive and cumbersome as that which they are intended to duplicate. In consequence there is a need for training devices that can be carried in ASW vehicles, which can break down the overall training into phases, imparting basic skills needed.

Training devices are needed in all areas, but are especially required in air-borne vehicles. In surface ships and submarines the entire A/S team can be trained as a unit, while the crew of each aircraft must be trained multiplying many times the services required.

ASW detection keyed to oceanography — While sound remains the primary detection medium, the possibilities provided and limitations imposed by ocean conditions will be considerable factors in determining effectiveness of A/S systems. Therefore, devices to measure and translate these conditions into operational criteria must be a continuing and growing need. Means of measuring the variations of velocity, temperature, salinity, magnetism, and bottom conditions are required. Equipment to compute, analyze, collate, and present these measurements in useable form, by unit and for groups is a corollary need.

As the submarine approaches a true submersible it becomes more and more dependent on its sound detecting devices for intelligence and for self protection. Further, submarines tend to place greater dependence on passive than on active means. Consequently the opponent is becoming increasingly susceptible to deceptive devices and countermeasures. Major effort in this field has been expended in devices to assist submarine evasion, but considerably less in providing antisubmarine submarines, aircraft, and surface ships with means for deceiving and confusing the target.

Concurrently with the incorporation of helicopters and rocket launched weapons into surface ships, means are becoming available for placing such countermeasures. Devices might be simulators to give the impression that: 1) additional units are present, 2) the detecting units are on a different bearing, 3) a weapon has been launched (to force initiation of premature evasion), or 4) surface or submarine units are present when only aircraft are engaged. Other devices might be jammers or deceptive communications producers. Countermeasures for A/S vehicles offer a fruitful field for simple, expendable devices, some of which should offer good cold war applications.

Mine warfare lags—Most of Navy's efforts are directed in adapting existing mine concepts to submarine defense. A further step to consider is converting some existing A/S torpedoes to mines and extending mine operations to deeper water. Mines being comparatively unintelligent are unconcerned about the power plant of the target they destroy and actuation ranges need not exceed one or two thousand yards. Hence, provision of A/S mines is more an engineering problem than a developmental one. Finally, to be useful, mines must be stockpiled before hostilities occur.

ASW control needs improvement — Control, as used here, is a rather general term to denote the data processing, communications, information analysis and presentation, and other needs to provide and disseminate intelligence and orders. Actually, it would appear that ASW control systems should be considerably simpler than other systems. Incorporating all features in a single system may only result in needless complexity. There is room for great improvement in ASW control, making it a fertile field for study.

Evaluation, key to effectiveness— The term evaluation, as used here, encompasses post-attack analysis both in war, in training and in evaluation of equipment, systems, and tactics. During World War II elaborate data taking was directed to enable subsequent analysis of attack effectiveness. In training, the requirements for data collection often interfere with operations. In cold war, the collection of data is often the only objective of the operation. In evaluation of equipments, systems, and tactics, the collection of maximum data is the only means of determining effectiveness, capabilities, and limitations. Therefore, means of collecting, collating, and analyzing the operations is of growing importance. Methods of doing this automatically and without interfering with the operations are needed.

Certain fields for study have been mentioned and others exist. For instance, adding an additional capability inexpensively to existing equipments offers possibilities. It would seem feasible to add a means of determining target depth and improving classification by utilizing a remote expendable sound source, explosive or mechanical. Since helos are being incorporated into many A/S systems, means for placing such sources are, or soon will be, available. Some devices developed as countermeasures might be used to attain this added capability.★

underwater sound

a comprehensive rundown of acoustical principles as they apply to latest asw

By LCdr. A. N. Glennon, USN

To really learn about sound in the ocean requires not only a lot of study, but a security clearance and a need to know. Even then you may find that just what goes on when and under what conditions may often be a matter of opinion—particularly as you become concerned with a greater and greater depth range. However, here LCdr. Glennon gives an excellent rundown of the principles that govern modern underwater sound—Ed.

The problem of detecting enemy submarines has been with us since World War I. As late as World War II, it had a solution—the Allies had defeated the Axis submarine forces by May 1943. But submarines used to be easier to find: in both World Wars, they had to surface to get air, to charge their batteries, and to get from one place to another.

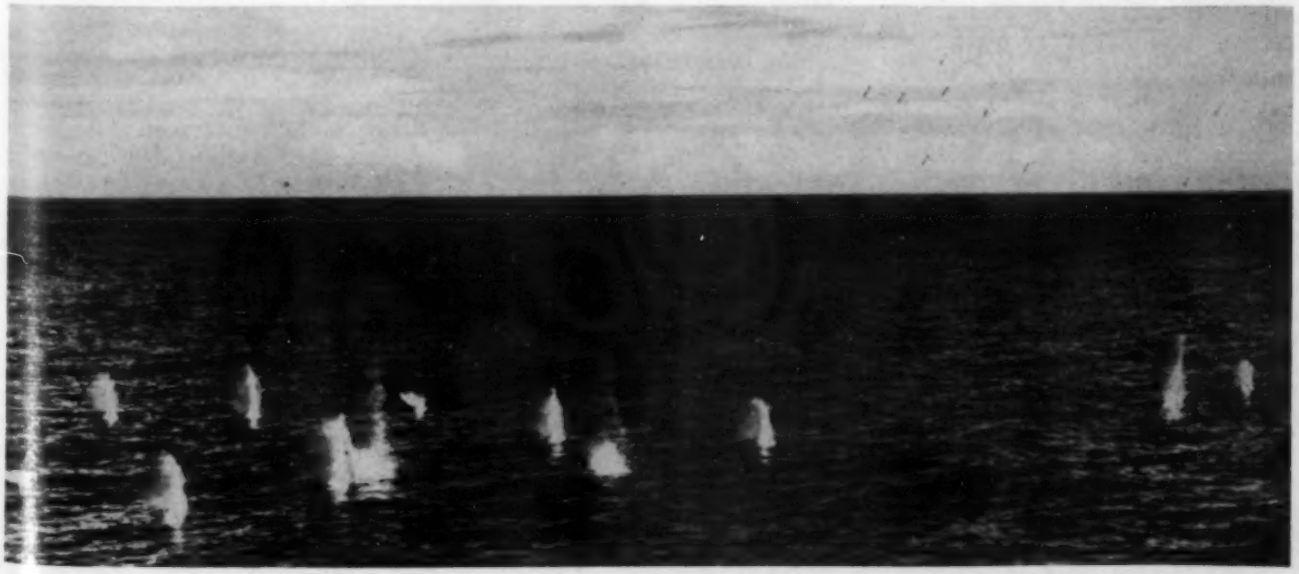
Nuclear submarines do not have these limitations. They can remain independent of the atmosphere for days on end; their batteries are kept charged and used only for emergency power; and they are able to travel at high speeds submerged for indefinite periods. These characteristics of the nuclear submarine mean that antisubmarine warfare in the future will depend more on sonar than ever before. A nuclear submarine skipper will not consciously expose himself to visual or radar detection; he will have means to insure that he does not unconsciously do so.

Since sonar plays such a big part in underseas warfare, it is essential that everyone working in this field have at least a basic feeling for the capabilities and limitations of underwater sound. This resumé may help those working on other aspects of underseas warfare to appreciate the problems of the sonar engineers.

If, for a moment, we think of the velocity of sound as being constant throughout the ocean, it should be apparent that a very short pulse of sound from a non-directional source will form a spherical shell of acoustic energy about this source; this shell will expand at the velocity of sound. Aside from modifications of the expected straight-line paths, created by the variations in velocity that are always present, sound does propagate in the ocean by spherical spreading.

Many sonars are able to produce a beam which concentrates most of the acoustic energy into a cone. Within the beam, the energy still spreads spherically, since this cone is simply a sector cut out of the omnidirectional sphere. Sound at reduced intensity will go out in directions other than along the desired beam. These side lobes propagate at exactly the same velocity as the main beam, but since they start at a much lower power level, they dissipate rapidly.

Measurements of sound intensity start one meter from the face of the transducer (See: "Transducers: Key to Sonar", Underwater Engineering, Vol. 1, No. 2). The intensity at this point is called the



One of the many objectives of accurate underwater sounding and ranging: Here a pattern of striking hedgehogs strikes at an undersea intruder.

"source level" of the sonar, and is measured in decibels relative to the standard zero reference level. Sonar intensity is defined as the rate at which power flows through an area placed squarely in the path of the energy, perpendicular to the direction of travel.

The intensity of any sound decreases as it spreads from its source. It must decrease, since spreading forces the initial burst of energy to distribute itself over an ever-increasing area in accordance with the inverse-square law. Intensity, then, drops by 6 db every time the distance traveled doubles. Spreading loss in the first thousand yards of travel is nearly 60 db, but only 6 db more for the next thousand yards.

A second loss that occurs in propagation is due to molecular friction. The wave motion is transmitted by vibrations of water molecules, which oscillate along the line of propagation. A portion of the acoustic energy is converted to heat in the transmission process. An additional fraction of the energy is lost to molecules which absorb it for self-excitation. The attenuation due to these molecular effects varies with frequency. At about 10 kilocycles, it amounts to 2 db per thousand yards. It increases with increasing frequency.

Sound velocity varies with water temperature, depth (pressure), and salinity. The most serious effect of velocity variations lies in refraction of sound rays. Sound paths are almost always curved by refractive effects, and the curvature is always toward a region of slower velocity.

Refraction is the cause of most of our sonar problems. When we speak of poor sonar conditions, we are usually referring to severe refraction, starting at or near the surface.

Reflections can cause nearly as much trouble as refraction. Ideally, a sonar would pick up reflections only from submarines or other targets. Practically, however, undesirable reflections are much more numerous than target echoes. Not only the surface and bottom of the ocean, but other ships, fish, bubbles, plankton, seaweed, and temperature discontinuities all contribute. At times, the sum of these undesirable reflections can blank out all other returns. This effect is described as reverberation.

Sonars cannot measure range in the true sense of the term.

Fortunately, we can make some inferences about range, based on what we guess to be the average sound velocity. If we knew the velocity accurately, we could infer a very accurate range. However, velocity always varies with depth, and may also vary with range and bearing. Finally, the gradual warming of the ocean during the day, and the cooling after sunset will cause it to vary with time. Under the circumstances, you can pick almost any reasonable number, and not be called a liar.

In practice, a fairly good estimate of average velocity can be made and used. Range errors due to inaccuracies in the estimate grow smaller as range closes, so accurate attack information can be obtained.

A velocity gradient, or change with depth, is positive if velocity increases with depth. Near the surface, positive gradients occur from time to time, while at very deep depths, there is always a positive gradient.

Whenever a positive gradient exists, channeling of sonar energy can be expected, because sound rays always bend toward regions of slower velocity. With a positive gradient, there must be a velocity minimum at some depth; the velocity of sound will therefore increase as its depth is changed in either direction from the depth of minimum velocity. Sound trapped in a channel of this nature spreads cylindrically, rather than spherically; since spreading loss then becomes only 3 db each time the distance doubles, channeled sound can travel great distances. An article in *Science Illustrated,* in April, 1947, reported that explosions from charges set off in the deep channel had been detected at ranges of 3100 miles.

Channeling can occur near the surface, even though the minimum velocity may be at or near the surface.

Some method is needed to tell whether a particular sonar is performing at its best from day to day. One means of judging performance is by Sonar Figure of Merit.

This is the difference, in decibels, between the source level of the particular sonar, and the strength of the weakest echo an operator can detect.

Figure of Merit has a major weakness: the variations in operator performance. The best and poorest operators on any ship are likely to have a spread in their ability which could cause a variation of several db in Figure of Merit, even though the equipment always performed identically. Additionally, an individual operator may show a wide spread in performance from day to day.

Eliminating the operator from the measurement, a different number, Sonar Performance Figure is obtained. This is simply the difference between source level and background noise.

Either performance measure, properly interpreted, can serve as an indicator of potential sources of trouble before they have a chance to develop into serious problems. Performance Figure also serves as an approximate method of comparing similar sonars on different ships.

As low frequency sound propagates better than high, it would seem logical to build lower frequency sonars. The reason we don't go lower is that, for good target resolution, transducer size must be roughly proportional to wavelength. To halve the frequency, transducer diameter must be doubled, and the weight quadrupled, unless some weight-reduction technique can be applied. We soon reach a practical limit to how much we can hang underneath a ship.

Another logical suggestion is to put more power into the water. Here, again, we run into limits. The face of a transducer that is driven too hard will cavitate. Once the cavitation limit is reached, power output into the water will decrease. Beyond this source level, each 3 db of additional intensity requires a doubling of the active area of the transducer. Once more, size and weight limit the number of 3 db increases that can be built into a practical transducer.

Any sonar set represents a compromise among source level, frequency, and transducer size. Even though we make the best possible compromise, the local properties of the ocean will ultimately determine how well any sonar will perform at a particular time and place.

Conventional sonars have reached a point in their development where only marginal improvements can be expected in the future. For the degree of improvement we must have, if detection capabilities are to keep pace with weapon developments, we must find novel means to overcome what appear to be the limitations nature has imposed on sonar. Even better, despite the promise shown by some of the experimental types now under development, would be a completely new detection method: one which does not depend on acoustic or electromagnetic waves.★

pressure testing facility

produced inexpensively from 16-inch naval shells

By

Harold E. Edgerton
Massachusetts Institute of Technology

Lloyd D. Hoadley
Woods Hole Oceanographic Institution

Underwater engineering is primarily a science. As an applied technology it is in its infancy. Few of the tools long taken for granted in the old technologies yet exist in oceanography and undersea technology. And those that do exist for detailed study of the oceans, environmental simulation, etc., are more often than not very costly. This article provides a valuable lesson in how to make do within the limits of available hardware and limited funds. Let's have more articles like this—Editor

Anyone concerned with deep-sea environment instrumentation must devote considerable time and effort to the routine testing of components in pressure-resisting watertight cases. It is the intent of this article to describe a system employed at Woods Hole Oceanographic Institution and Massachusetts Institute of Technology for producing hydraulic pressure. The equipment is relatively small and can be operated by one person and should be of interest to others who have a need for pressure testing of devices that are to be used at great depths in the sea.

The Pressure Chamber — A very convenient enclosure for a 20,000-psi test facility is the obsolete 16-in. naval shell (high-explosive type). Since the shells will never be used again for their original purpose and are in the nonessential stores, procurement is routine to military and educational groups. There is probably some method of obtaining the shells as surplus material after the explosive charge has been removed.

It is believed that Maurice Ewing, Allan Vine and Joe Worzel, when at Lehigh University, were the first to utilize the shell as a pressure chamber. When the group joined the staff at WHOI it was a natural consequence to duplicate the installation. Results were good, as can be attested by a host of oceanographic equipment, thereby contributing greatly over the years to oceanographic instrumentation. Accompanying sketch shows the WHOI pressure-test facility with its new hydraulic system.

A similar system, recently installed at MIT, is performing excellently in experimental development of windows, electrical seals, pressure cases, sonar transducers, etc.

The maximum diameter of the opening in the 16-in high explosive shell is about 8¼ in. A usable length of 3 ft can be accomodated inside. The fuze plug can be supplied with electrical Joy plugs, type number X8372-103, for bringing through electrical connections for test purposes. The corresponding connector is Joy plug number X8372-32. This is a great convenience in experimental work. Eventually a window may be installed so that optical, as well as electrical tests can be made from the outside.

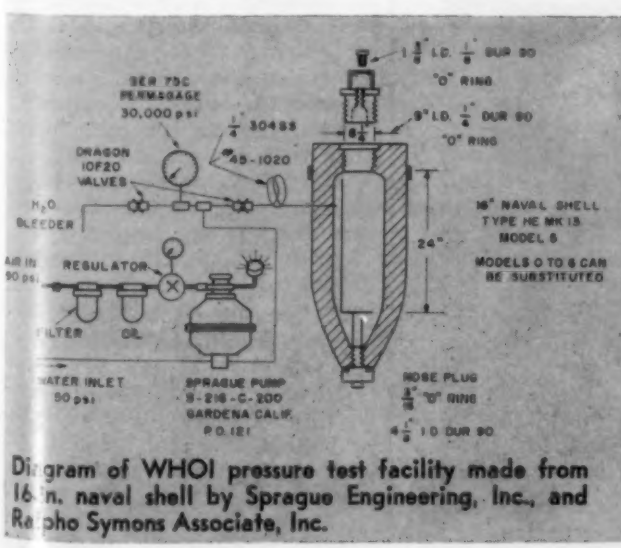
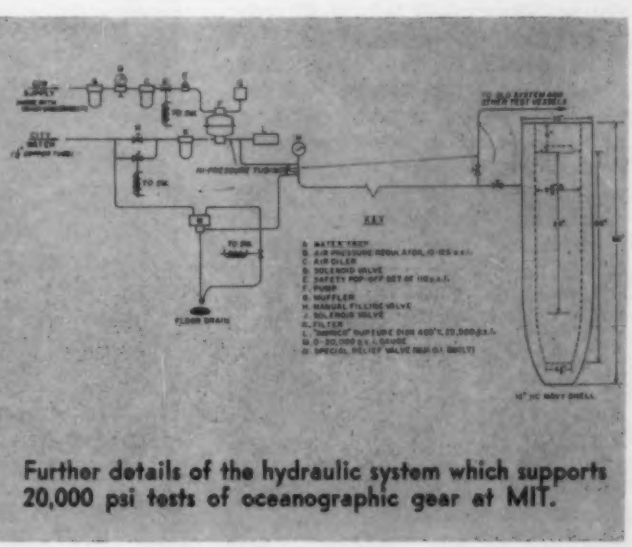


Diagram of WHOI pressure test facility made from 16-in. naval shell by Sprague Engineering, Inc., and Rapho Symons Associate, Inc.



Further details of the hydraulic system which supports 20,000 psi tests of oceanographic gear at MIT.

There are several types and styles of 16-in shells, so it behooves the user to determine which shells are available to best meet his requirements. For example, the WHOI shell is about 1 in greater in diameter than the MIT shell. Information concerning the armor-piercing shell is unavailable to the authors, but it is believed that the internal capacity is half the volume of the high-explosive type.

The nose cone, supplied by the Navy, has a hole through the center, which can be plugged by welding in a solid steel rod. However, at MIT, a new solid-end cone was turned out of steel since the first weld leaked badly. An "O" ring (3/16 in) was placed in the edge of the cone to seal the pressure. If this were to be done again a ¼ in. "O" ring of "durometer-90" rubber would be used, since some difficulty was encountered with blowouts of the smaller "O" ring of softer rubber.

Pressure sealing of the breech plug is accomplished by fitting a brass ring tightly against the shoulder of the plug. The ring has a height of 0.22 in and a thickness of 0.125 in. The rubber "O" ring should fit snugly inside the brass ring. It is very important to screw

Fuse plug equipped with electrical Joy plug carry sensors for test.

the breech plug in tightly in order to prevent the rubber ring from being squeezed into the shoulder space. Should this happen the rubber ring may become so distorted as to make removal a difficult task. Even the "durometer-90" "O" rings will suffer a small loss of rubber each cycle.

Details of the hydraulic pressure system are shown in the diagrams. The Sprague pump (Sprague Engineering Corp., 19300 South Vermont Avenue, Gardena, Calif.) produces the hydraulic high pressure in the pressure vessels. Arrangement of the pump and other devices—such as valves, gages, etc.—was designed by the Ralph B. Symons Associates, Inc., 3571 Main Road, Tiverton, Rhode Island.

Deep water strobe unit is lowered into chamber for pressure test.

A typical pressure time relationship for the MIT pressure tank is given below:

Time	Pressure
2 minutes	5,000 psi
4 "	8,700 "
6 "	12,500 "
8 "	14,600 "
10 "	16,300 "
15 "	19,000 "
20 "	21,000 "

The regulator on the MIT air supply is adjusted to give a final peak pressure of 21,000 psi. It will hold any desired pressure — pumping as required to compensate for any slight leaks in the valves and glands.

Funds from the Research Committee of the National Geographic society were used to obtain the WHOI and MIT high pressure pumps and hardware.★

Sealed 16-in. shell is lowered into test fixture for pressurization.

Richard E. Munske Joins Sheffield Staff

Sheffield Publishing Company is pleased to announce the appointment of Richard E. Munske as Science and Industry Editor of Underwater Engineering and GSE magazines.

In this capacity he will be our main contact with the technological aspects of industry. He will monitor new developments in the fast developing fields of oceanics, underwater engineering, and the general over-all field of undersea technology.

In this latter regard, many of the releases we receive fail to point out the specific underwater application for which they are best suited. To help us to present your new underwater products in the best possible light, we urge you where feasible to spell specific UE applications.

Mr. Munske has had several years experience in the fields of electronic engineering, technical writing, and statistical studies. He joins Sheffield from Edward T. Johnson and Assoc. where he served as staff associate.

Prior to that, Mr. Munske was associated with Avion Div. ACF Industries, John I. Thompson and Co., Melpar, Inc., Geophysics Lab.-U.S. Geological Survey, and Resources For The Future.

Author of several data processing manuals and ordnance handbooks, Mr. Munske also has recent reports on water requirements for the future listed with the congressional records. In addition, Mr. Munske has worked on complex studies in the areas of geophysics, photogrammetry, isostatic measurements, and industrial engineering. He has headed a 35-man team which performed sonar studies for the Coast Guard.

Mr. Munske received his education in physics and mathematics at Texas A & M and American University, receiving his graduate degree in mathematics at the latter. He has since been doing graduate work at American University in science and philosophy.

problems in u e

Designing for the sea environment — whether it is advanced materials, shipboard electronics, propulsion, hydrodynamics, or something just to help the man at sea do his job better — continues to be the paramount problem of Navy research and development.

And surprisingly enough, the bigger technical bureaus of the Navy Department are not the only talent scouts for industrial ideas and solutions. Bureau of Supplies and Accounts, Bureau of Medicine, and Bureau of Yards and Docks — often regarded as stepsisters to the Big Two — all have requirements in the ocean environment.

Their problems deal mostly with the human factor and logistics support. But whether it is chemical sciences, data processing, electronic sciences, fabrication technology, life sciences, engineering mechanics or materials sciences — these bureaus often play a necessary role in securing these scientific and engineering needs. It is well to remember too that they have contractural authority. Here are examples:

BUREAU SUPPLIES & ACCOUNTS

BUSANDA, the paper-burdened agency which must supply a worldwide network numbering thousands of personnel and hundreds of ships and shore stations, is wrestling with automation.

Problem: Sorting documents — Supply applications, whether from the FBM submarine tender *Proteus* or an oceanic research craft, require generation of multi-part documents that require sorting according to various criteria. Now it is done manually, or converted to punch cards. BUSANDA would like to see original papers passed through an optical character recognition device and sorted directly. The device should have both counters and accumulators, so that both the total number of documents per category and the total value per category could be readily determined.

Problem: Source Data Automation — Needed is a low-cost paper tape generator for direct input to computers. BUSANDA feels currently available source data automation equipment costs too much for other than high-volume activities. It desires a generator which would produce both hard copy and paper tape. Characteristics desired: (a) Printout on tapes at time of generation permitting audit prior to transmission; (b) No generation of special functions, such as line feed or shift from upper to lower cases; and (c) Tape generation by manual key-strokes, or partially manually and pre-coded plates.

Problem: Food Handling — The Navy travels on its stomach too, and BUSANDA is plagued by that standing bugaboo — lack of shipboard space. BUSANDA would like an economical method of compressing flour to reduce its storage space on board ship. Needed: A means of compressing it so it can still come out of storage soft and fluffy for handling in the bakeshop. And powdered "delicacies?" They still have the same appeal that did 17 years ago — zero. The man at sea still wants his eggs "sunnyside up" and his steaks grilled. Problem: Not enough space for all the griddles required. Needed: Faster means of grilling, perhaps by infrared.

Mess trays after washing still are as wet in days of old. They still take up too much space. Needed: A small system of hot air drying after the washing cycle.

Problem: Fuel Handling — A non-combustible impermeable coating for fabric to protect handlers of liquid rocket fuels and oxidizers is still a pressing requirement. Navy feels vinyl impregnated fiber glass fabrics offer inadequate protection, and that while modified butyl coatings give acceptable protection from penetration by corrosive liquids, they also support combustion.

Along the same lines, BUSANDA wants a closed cell polyurethane foam, or like material, for insulation and buoyance in Navy shipboard cold weather clothing.

BUREAU OF MEDICINE

In the field of life sciences, there are many problems under the cognizance of the Bureau of Medicine, particularly those dealing with submarine and diving, associated with the human tolerance in these unusual environments. The advent of the nuclear submarine has increased these problems, providing new and fertile fields for industrial and institutional research.

Needs of Conventional Sub — First, there are problems of personnel assessment. Here the field runs the gamut of relationships: Predicting motivation and qualities of leadership; interactions of groups and how their attitudes are motivated; and how to select, motivate and enlist personnel in the submarine service.

Secondly, problems of closed environments. What are CO_2, O_2, N_2O toxicity after long periods of exposure at normal and elevated pressures? What is the toxicity of volatile hydrocarbons, and chemicals? What is the toxicity from other sources?

Needs of Nuclear Sub — Personnel problems, as mentioned above, essentially are the same. But new problems, radiation for one, which must be dealt with the same as in aviation and space medicine have come to the fore.

And again, there is "esprit de corps," having a direct application to submarine medicine. The nuclear submarine force has been relatively small, and pride of being "first" among the volunteers has helped to make it a selective arm of an already selective branch of the Navy. But how — as the number of personnel required increases, particularly with the multi-FBM boat fleet — do you keep this spirit and retain the highest caliber of personnel as volunteers?

Still another fertile field for investigation are the effects of long exposure — 30 to 90 days — of atmospheric contamination. Just how harmful is carbon dioxide, volatile agents, particulate matter from smoking, freon from refrigerants, etc.? Today, there's a startling demand: Investigation of practically every new product or piece of equipment placed aboard a submarine for possible sources of atmospheric contamination.

Underwater Swimming Problems —Naval medical authorities are taking a big look at such things as: What is the oxygen tolerance (amounts and types of gases to be mixed with the swimmer's breathing air)? How do you prevent oxygen convulsions? How do you prevent decompression sickness among SCUBA divers when they must operate at multiple depths and varying times of exposure? How do heat and cold stresses effect a diver's performance? Lastly, what are the effects and possible treatments for underwater blast injury?

This has been only a sample rundown on some problem areas being dealt with by three relatively unknown Navy bureaus. They — along with BuShips and BuWeps are actively seeking solution in the biggest problem area of all — the ocean environment. The field has never been better for industry and institutions which can come up with new ideas.★

torpedo water entry

By Barron Kemp

Aircraft-launched and rocket-thrown torpedos are subjected to many types of severe mechanical shock excitation throughout their service life.

This is a very critical time in the life of a torpedo since the weapon must accomplish its mission immediately following water entry. Therefore, it is mandatory that all internal electronic and electromechanical torpedo components survive this dynamic-loading condition without permanent damage.

The most important considerations at water entry concern the dynamic responses of internal components to the forcing accelerations. These responses can result in deflections great enough to cause rupture of materials, permanent deformations, and collision between adjacent components.

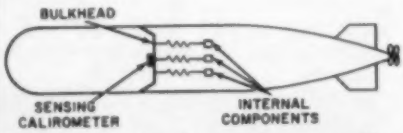


Fig. 1 — Accelerometer mounting method.

Fig. 1 illustrates a torpedo shell housing a single component-supporting bulkhead. Electronic components are represented as simple spring-mass oscillators. A miniature accelerometer rigidly attached to the bulkhead will not sense the acceleration forcing function which excites the bulkhead; rather, the ultimate response of that structure to the forcing function. In turn, the recorded acceleration history acts as a forcing function which excites those components attached to the instrumented panel. A response or shock spectrum computed for this accelerogram gives a valid indication of the ultimate response characteristics of the attached subassemblies.

The technique consists of computing the response spectra for acceleration histories occurring in high component density areas of the torpedo. These spectra are then superimposed to obtain a service spectrum of maximum envelope. The resulting shock data dictates any acceleration-time pulse which yields a response spectrum that approximates the maximum envelope of the superimposed service spectra. This technique involves duplicating the effect of the environmental shock rather than the shock itself. Values derived by this technique are valid only for internally-mounted components and not for the torpedo shell.

The experimental techniques are more valid when the internal torpedo components approximate single - degree - of - freedom oscillators rather than more complicated designs. Because the first-order shock spectrum does not indicate phase relationships between responses of various models, certain difficulties arise with multiple-degree-of-freedom structures. Modified techniques are valid not only for the simple structure, but also consider coupled oscillators to a certain degree. However, because the more refined approaches require complicated data

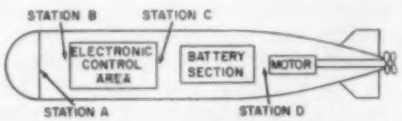


Fig. 2 — Instrumentation pattern.

reduction techniques, any sacrifice in accuracy is outweighed by the advantages offered by simplicity.

Instrumentation — Fig. 2 illustrates the four internally instrumented stations where minitaure piezoelectric accelerometers are mounted. Station A is at the rear face of the homing device, one of the most important and vulnerable assemblies of the torpedo. Stations B and C are the forward and rear bulkheads of the electronic control section. Since this section contains most of the electronic hardware of the weapon, it is of direct interest to investigate this area. Station D is located at the bulkhead which supports the forward motor-bearing assembly. This bulkhead also supports the main start and power relays. Any damages which might occur in the propulsion system would likely result at this station because of the delicacy of these relays.

A block diagram of one instrumentation channel is shown in Fig. 3. Because of the difficulty encountered in obtaining internal recorders or telemetering transmitters which operate satisfactorily at the high-level water-entry accelerations, an antimicrophonic trailing cable is used to transmit the accelerometer signals to shore-based amplifying and recording equipment. A tape recorder utilizing frequency modulation is used in parallel with an oscilloscope equipped with a high-speed 35-mm camera.

Test Facility — The slingshot facility at the Morris Dam Torpedo Range is generally used for field launchings during tests of this type.

Response spectra for the resulting accelerograms are resolved with the aid of a passive-type analog computer consisting of a series of simple electronic oscillators which respond according to the force-voltage analog. Shock spectra are computed between frequency limits of 100 and 2400 cps.★

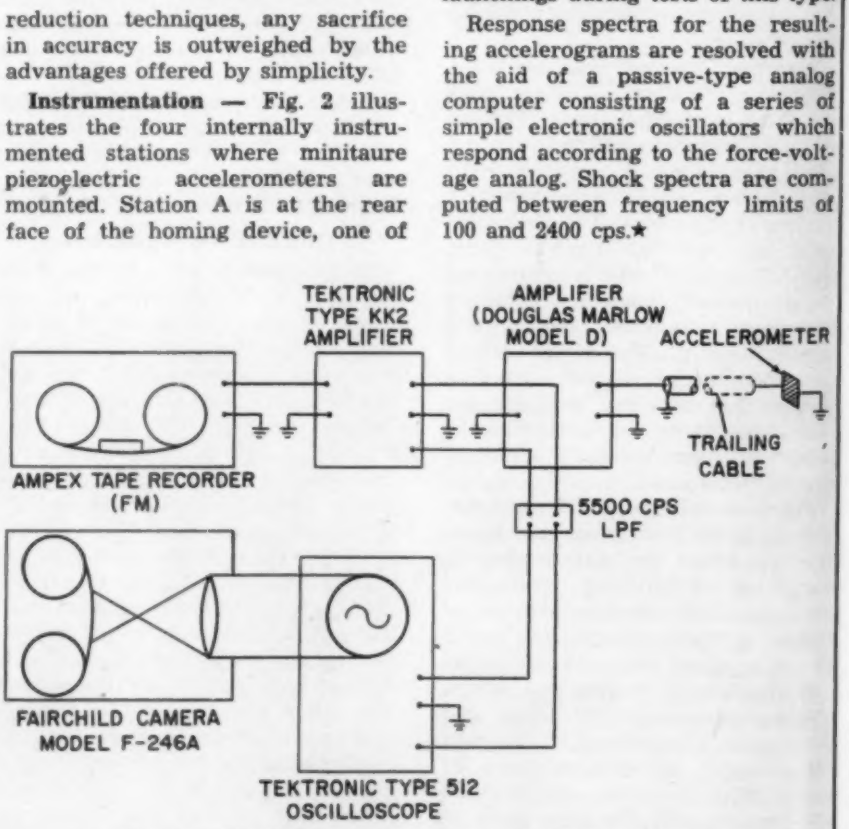


Fig. 3 — Block diagram of one instrumentation channel.

TORPEDO COUNTERMEASURES

By James C. Moore and Charles C. Cartwright
Torpedo Countermeasures Branch
U. S. Navy Mine Defense Laboratory

The opinions or insertions in this article are the private ones of the writers and are not to be construed as official or reflecting the views of the Navy Department or the U. S. Navy Mine Defense Laboratory.

Let's retreat from the realm of outer space and catastrophic weapons long enough to appraise the potential threat from inner space and conventional weapons. It is now generally believed that any future conflict might well not involve nuclear weapons since a retaliatory effort by an enemy would almost surely impose unacceptable losses on the aggressor. A long, carefully-planned, limited war appears to be more probable for the achievement of political objectives.

In such a war, the naval torpedo would be a primary weapon of offense against our merchant and naval ships and it could present a far greater threat than during the U-boat campaign of World War II in which nearly 3,000 allied ships of 15 million tons were sunk by torpedoes. It is also generally believed that the survival of our nation is now more dependent than ever before on our control of the Atlantic and our maintaining shipping among the NATO countries, and that the United States must be able to successfully fight a limited war if it is to continue in its historical role as guardian of world democracy.

When we consider these strategical requirements, together with the facts that material and equipment required for modern warfare are far greater and heavier and that our armies and navies are more mobile than during World War II when 8500 tons of cargo were delivered every hour of every day and night, we can see that not only will it be necessary that we maintain our vital supply lines and control of the seas, but that the task of doing it could be tremendous and could place large demands on our naval and merchant fleets.

Not considering NATO supply requirements, today it takes approximately four tons of shipping to supply every soldier landing in a mechanized assault and an additional two tons to supply him each month and it takes many tons of shipping to supply our naval task forces and overseas air and missile bases.

Defending our ships in a future war where large amounts of overseas shipping are required could place prohibitive demands on conventional Anti-Submarine Warfare and naval escorts. In such an event, it is unlikely that sufficient escort vessels will be available. In both previous wars escort vessels always were in short supply. For this possibility, a torpedo countermeasures system is requisite both for protection and morale.

Currently, there are a limited number of scientists and engineers struggling with the knotty problem of developing countermeasures which can be used in defending our ships against enemy torpedoes. Work in this field is directed by the Bu-

(Continued on page 34)

U. S. Navy Mine Defense Laboratory

The U.S. Navy Mine Defense Laboratory is located 100 miles east of Pensacola, Florida and 10 miles west of the center of Panama City. Covering 728 acres it is situated on the shore of St. Andrew Bay, 3 miles from the Gulf of Mexico by the nearest navigable channel. This location provides a well protected harbor in an area with little ship traffic and offers climatic conditions which permit year-round sea test of new equipment.

The Laboratory conducts never ending studies of defense against mines and torpedoes. It is the Navy's principal scientific center devoted to the study of these underwater weapons. A division of minesweepers from the Atlantic Fleet and a group of helicopters are also stationed at the installation. Historically, the Laboratory started as the Navy Mine Countermeasures Station in 1945 and was commissioned the Navy Mine Defense Laboratory in 1955.

A three-story permanent building was completed during 1957. This main building houses the scientific and administrative functions of the Laboratory. Outlying buildings house the many functions peculiar to mine and torpedo countermeasures development; technical shops, test facilities, magazines, swimmer and diver support facilities, ship tracking towers, as well as conventional shops and service.

The research and development staff is composed of professional people and aids from all branches of physical science and engineering; a substantial nucleus of whom are national authorities in mine and torpedo countermeasures. The civilian staff is complemented by naval officers and enlisted personnel who provide engineering and supply support as well as air and sea-going services.

reau of Ships and is conducted by a small number of government and private industrial laboratories. The U. S. Navy Mine Defense Laboratory, Panama City, Florida, has been designated the Navy's key Laboratory for torpedo countermeasures systems development.

This Laboratory is responsible for conducting research, development, test, and evaluation of Torpedo Countermeasures Systems. At this Laboratory, engineers, physicists, mathematicians, and technicians, working close to the natural environment, pit their energy, knowledge, and know-how against one of the Navy's toughest problems.

Countering the modern torpedo is a difficult problem because of the nature of the weapon. Torpedoes in their present development are weapons of such a complex nature that effective countermeasures tend to be of equal or greater complexity. The designer is faced with an underwater guided missile which may be expected to be fast, difficult to detect, wakeless, capable of being fired from long ranges and from great depths, and capable of "homing-in" on its target by means of a complex guidance system.

Torpedo countermeasures systems fall rather naturally into three categories:

First, there are the tactical countermeasures — these are ship maeuvers designed to evade torpedoes.

Second, there are tailored countermeasures such as decoys, jammers, and maskers which are designed for use against particular varieties of torpedoes such as the acoustic homing type.

Third, there are the so-called "universal" countermeasures which are generally effective against all types of torpedoes and which generally employ explosives as a means of destroying, deflecting, or otherwise preventing torpedoes from reaching their targets. The optimum torpedo countermeasure system is one which is effective against most kinds of torpedoes and which is inexpensive, simple, rugged, reliable, and capable of being manned, operated and maintained by the average crew of a naval or merchant ship without interfering with the normal operation of the vessel or imposing undue restrictions on deck space. These requirements result in a real challenge to the designer. Many problems in this field remain unsolved. Acceptable solutions to these problems, as well as new ideas, are urgently needed in the struggle for the defense and security of our nation.★

emergency respirators fitted to a-submarines

"I realize we would have to devote more attention to fire hazards . . . we would have to have some kind of a special breathing apparatus to protect the crew in case of fire . . . while we were submerged under the pack."

These are the words of Cdr. William R. Anderson, U.S.N., skipper of the SS(N) *Nautilus* when that atomic-powered submarine made its historic voyage from the Pacific to the Atlantic Ocean beneath the Arctic ice.

The need for special breathing devices actually did occur, but when the sub was enroute from Panama to San Francisco just a few months prior to its pioneer under-ice voyage. Emergency smokeproof breathing apparatus was installed. Since then, similar equipment has been placed aboard all other U.S. nuclear subs, including the SS (N) *Seadragon* — which recently completed an Atlantic-Pacific polar crossing.

Cause of the *Nautilus* fire was oil-soaked insulation around the sub's port high-pressure turbine. High-speed running in warm, tropical waters apparently caused the blaze and resulting smoke which LCdr. William G. Lalor, Jr., main propulsion officer, described as "acrid." The *Nautilus* was able to surface to rid itself of the fire and smoke.

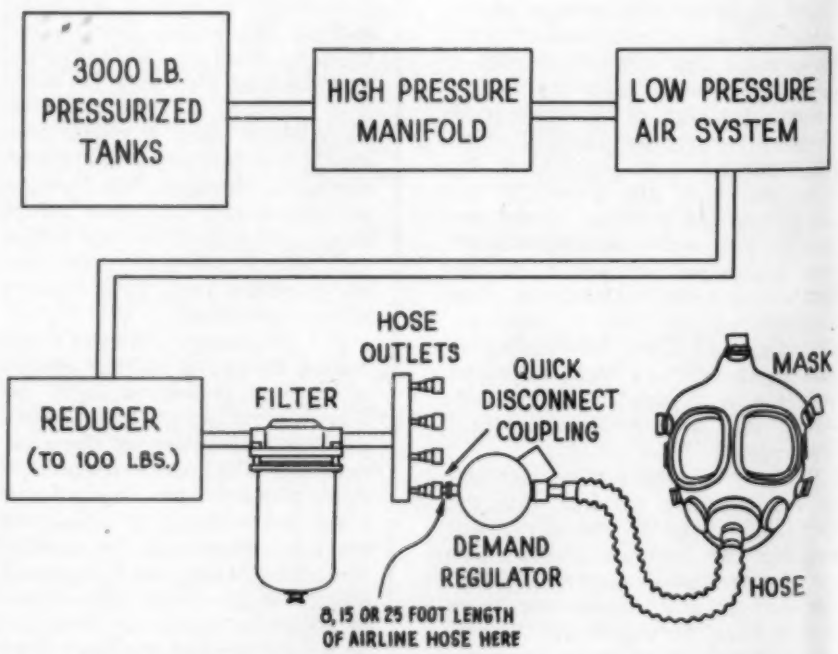
This experience revealed the urgent necessity of installing emergency breathing equipment aboard subs involved in polar voyages.

Based on the emergency *Nautilus* installation, placement of special apparatus on the *Seadragon*, commissioned late in 1959, is typical of that employed aboard other ships in the U.S. atomic sub fleet.

Although the sub is designed for about 85 men to live comfortably while totally submerged for long periods of time, it is equipped with 155 air lines respirators — packaged in synthetic leather and stored in various areas for immediate use under all possible conditions.

The lightweight respirator's design is particularly suitable for use where protection for the face and eyes is a necessity. The speaking diaphragm facepiece provides an airtight seal through use of adjustable headstraps.

The respirators, made by Mine Safety Appliances Company, Pittsburgh, permit the wearer to plug into any of 50 two-outlet or four-outlet manifolds equipped with quick disconnect shut-offs. The system originates from the 3000-pound pressurized tanks used for surfacing and torpedo firing and is reduced to 100 pounds pressure before pass-



Schematic of air upply system for A-sub emergency respirators.

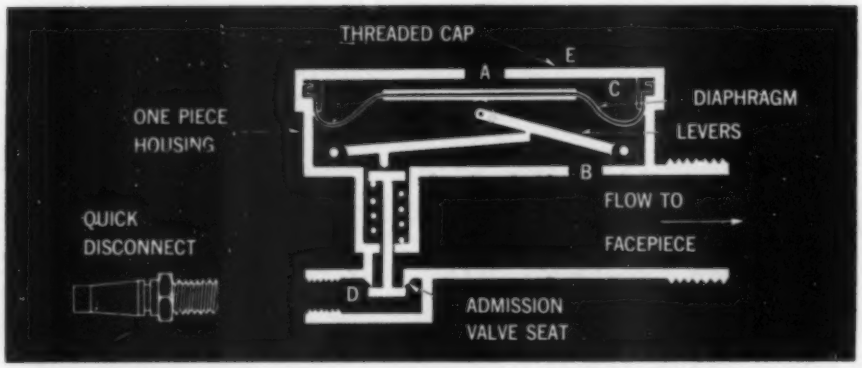


Diagram of easy flow aspirator to facilitate breathing.

ing through an MSA line filter. This removes organic vapors and particulate matter.

To determine positioning of the respirators, LCdr George P. Steele, captain, and LCdr Lalor (the main propulsion officer on the *Nautilus*), engineering officer, and others considered sleeping, eating-recreation, watch, and battle stations. Generally, most activity centers around the crew's messroom — largest open area aboard — and 53 of the respirators are stored in this area. Others are lockered in the control center, engine room, forward torpedo room, stern room, wardroom, and sonar, electronic equipment, radar, radio, and reactor areas.

"We wanted them where they could be reached quickly during any condition that would not permit us to breathe the ship's normal air supply," LCdr Lalor said. "The most probable cause of this would be fire. Of course there can be other causes too."

Located at the outlet stations are MSA demand air line respirators equipped with the all-vision, speaking-diaphragm facepiece, 28-inch corregated breathing tube, variable flow demand regulator, and 8, 15, and 25-foot sections of air line hose.

Depending on the emergency, it may be necessary to wear the equipment (respirators) for several hours. It has been designed with this in view. The demand regulator will perform satisfactorily between pressure ranges of 30 to 135 pounds per square inch and provide up to 200 liters per minute instantaneous flow.

The emergency air supply is filtered prior to storage but still travels through the distribution system through MSA air line filters. These filters contain both a chemical bed for removal of trace concentrations of vapors and a particulate filter with an efficiency of 99.98 per cent against 0.3 micron dioctyl phthalate smoke. A condensate trap is also part of the filter. A fraction of an inch of water column inhalation effort initiates flow to the facepiece of the demand air line respirator, and flows up to 200 liters per minute can be obtained with less than 1 inch of water column suction.

Maintenance of equipment aboard nuclear submarines is extremely critical. The emergency demand air line respirator system is handled easily since no special tools are required to maintain equipment. It is simple to disassemble and reassemble all parts, and replacements can be made, if necessary, through a minimum inventory on the sub.

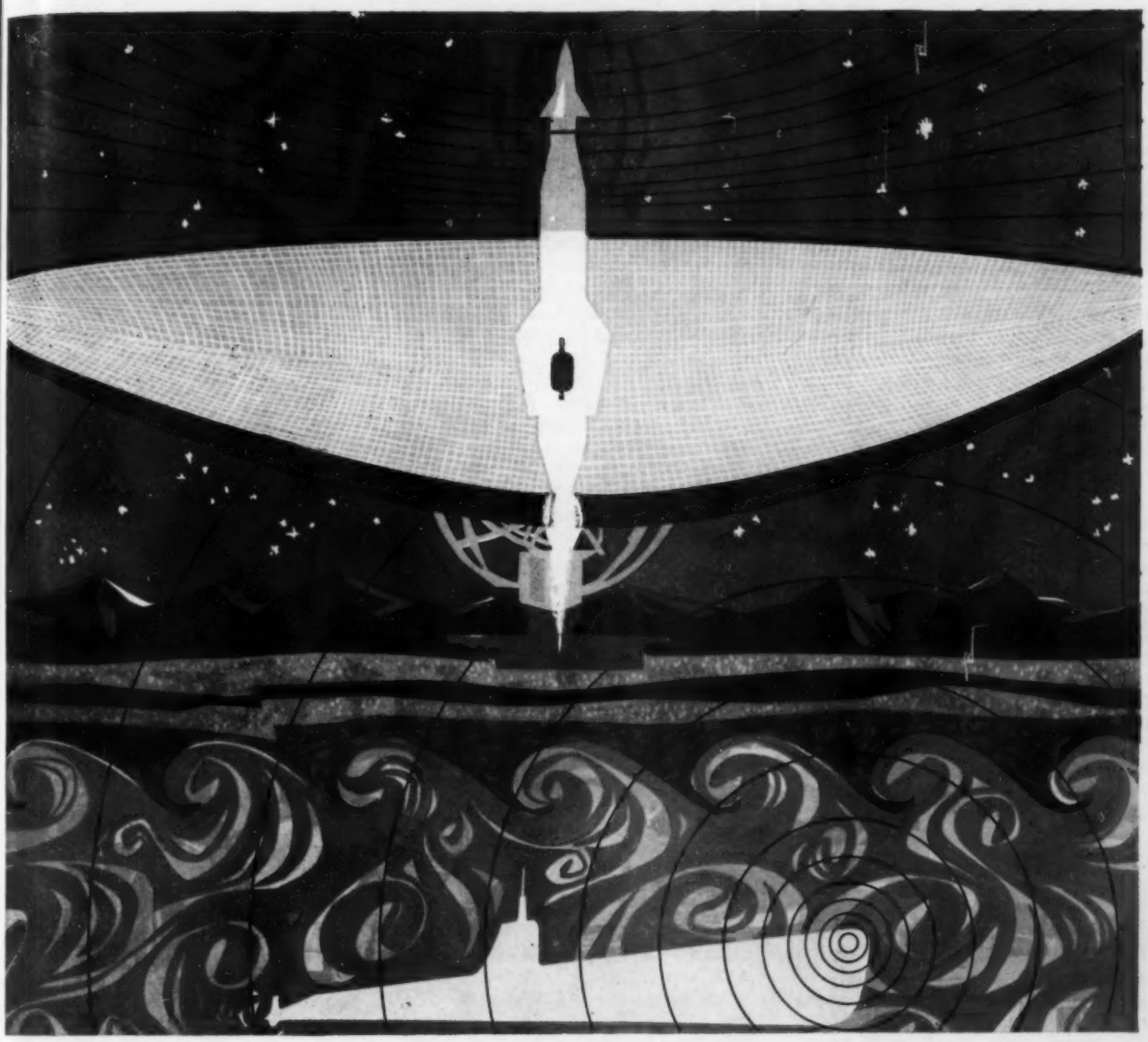
All regulators are cycle tested prior to shipment. All air line hoses must qualify for a 100-pound pull test on fittings and hose, a 250-pound working pressure, and a 1,000-pound bursting pressure.

The speaking diaphragm of the respirators is resistant to acid, heat, or corrosive materials. This device transmits speech naturally and without distortion in gas or smoke-filled air.

Availability of the speaking diaphragm permits continued use of the sub's sound-powered telephone system, according to LCdr Lalor. This uninterrupted use of communication is "valuable," he said. "You have to be able to talk to the man next to you, and with others in all parts of the ship."

Although there has been no emergency requiring use of the respirators aboard the *Seadragon*, safety drills are a regular part of sub life. For example, LCdr reported that the respirators were "broken out" at least 15 times during a two-month cruise.

There are special classes for all new personnel who are checked out on artificial respiration, use of the MSA respirator, and other first aid equipment and applications. The periodic drills — for fire, passive defense, radiation, steam leak, toxic gas, and other possible hazards — serve as a continuing check of these men and the "regulars."★



Brunswick Pioneers Applied Research and Development in Non-Metallics for Aero/Space

Whether your problem be one of design for space age needs of present or future; whether it be one for missile, mobile forces or underwater application; or whether it be one of fabrication know-how, you can look with confidence to Brunswick for the key to the solution if not the ultimate answer.

Consider epoxy resin VC-8359, developed by Brunswick for designs requiring superior performance in the area of modulus and high temperature durability for continuous usage. VC-8359 made practical one of the first all-plastic wings for a supersonic missile. This outstanding material know-how is also available in the polyester, ceramic, phenol-silane and silicone fields.

Coupled with this research and development capability is superior knowledgeability and experience in diverse manufacturing techniques ranging from conventional hand lay-up to the more sophisticated types of filament winding.

If your need is high temperature radomes for missiles, rocket motor cases with demanding heat and structural requirements, insulative structures, heat shields, airvanes or underwater structures, Brunswick's capability-plus for applied research and development in non-metallics affords you the best solutions.

Interested engineers will find it rewarding to discuss career futures with Brunswick. Write or call Brunswick Corporation, Defense Products Division, 1700 Messler Street, Muskegon, Michigan.

MAKES YOUR IDEAS *WORK*

Brunswick

Circle Reply Card No. 16

PIC reactivates WW II Navy Yard:

ue market booms in depressed areas

By Peer Fossen

While Congress and the President are trying to make up their minds as to the depressed area aid program, and who is to be on the receiving end of it, life in the distress areas moves on. Fortunately, rather than sitting back waiting for the Administration to arrive at a conclusion, there are creative minds on the look-out for opportunities leading to corrective action.

One example is Portland Industries Corp. in South Portland, Maine, which is operating a constantly growing business in the facilities known during WWII as the Portland Navy Yard. During the war, the yard was active around the clock producing Liberty-type cargo vessels. The plant, with its 500,000 sq ft of manufacturing area, and more than 3,000 employees, was shut down when peace broke loose.

Between 1945 and the Fall of 1960 the plant did some $25 million worth of military job-shop work.

Under the regime of Portland Industries Corp. less than 50 persons were occupied meeting the requirements of a few defense and industry subcontracts. Under these contracts PIC delivered such hardware as the shelter doors for the BOMARC installation at Bangor, Me., and scanner drums for BMEWS installations. The latter units, 11 ft high by 32 ft in diameter had to be turned to a specification accuracy of 5/1,000 in.

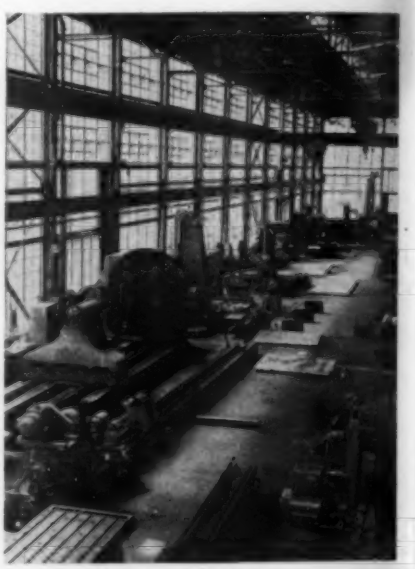
In the Fall of 1960, the PIC leaders took a close look at the operation. This resulted in a complete overhaul and the establishment of a program beamed at a concentrated effort on an over-all expansion in the defense field. Of particular interest were the areas of space and undersea technology.

To reach the set goals, Simon Srybnik, PIC Board Chairman, last Fall announced the election of Ira Kamen as President to head the organization. At that time PIC was at the tail end of its last defense subcontract. Today, only six months later, the backlog in defense contracts amount to nearly $4 million. Add to that the encouragement from a score of leading undersea technology companies.

Current contracts incorporate work on POLARIS, MINUTEMAN, and TITAN missiles, THRESHER-Class and POLARIS-Class submarines, scatter-communication antenna and maser components, TPQ 10 and MPQ 32 antenna components and molds, and nuclear guns and nuclear handling equipment. The latter for Lincoln Labs.

Realizing the potentials of PIC, one of President Kamen's first actions was to firm up a strong Board of Advisors consisting of:

- Sir Robert Watson Watts, "father" of radar.
- Dr. John Teeter, Head Technical Aide to Vanevar Bush in the Office of Scientific Research and Development.



Portion of PIC heavy machining facilities.

- J. R. Poppele, former Director of Voice of America, and President of the Television Broadcasters Assn.
- Dr. Lloyd Elliot, President of the University of Maine.

The immediate function of this board is not to guide PIC on the present state of art, but to provide guidance and long range planning for future achievements.

To insure these achievements, Mr. Kamen has also enlisted the support of University of Maine for research and study work, and union and vocational training authorities for upgrading local apt trainees to skilled machine operators. Under the program, the trainees get their education in PIC's plant on the machinery they will eventually operate. In this manner PIC has a backup program in its growth plan in the event the company will be in a position to absorb all skilled workers in the Portland area.

From a hardware point of view, PIC has unlimited possibilities, especially in the field of heavy machining. Its machining facilities are probably the most modern and complete on the East Coast. PIC has at

Over-all view of Portland Industries Corp. plant, South Portland, Me.

PIC President Ira Kamen.

the present time more than 500 pieces of machinery at its disposal, some of it new, the rest completely rebuilt and modernized to meet exacting specifications.

PIC especially hopes that these massive machining facilities will bring in substantial work loads in the huge antenna and heavy antisubmarine warfare hardware fields.

The combination of the metal working facilities with spacious buildings — 60-ft high bays — and existing waterfront facilities capable of handling ocean-going vessels gives PIC a rather unique set of features.

In the words of President Kamen: "If we started from scratch, we would not create a facility better suited for the manufacture of heavy antisubmarine warfare hardware, antenna systems, nuclear components, and large computer-type consoles.

"Our buildings can accommodate complete sectional parabola antennas as large as 130 ft. This means that large size antennas can be built, assembled, and tested indoors with work going on uninterruptedly 365 days a year.

"Our waterfront facilities capable of accommodating deep-sea vessels, will help eliminate problems in transporting massive assemblies overland. To mention one example, two Texas Towers were built and shipped directly from here.

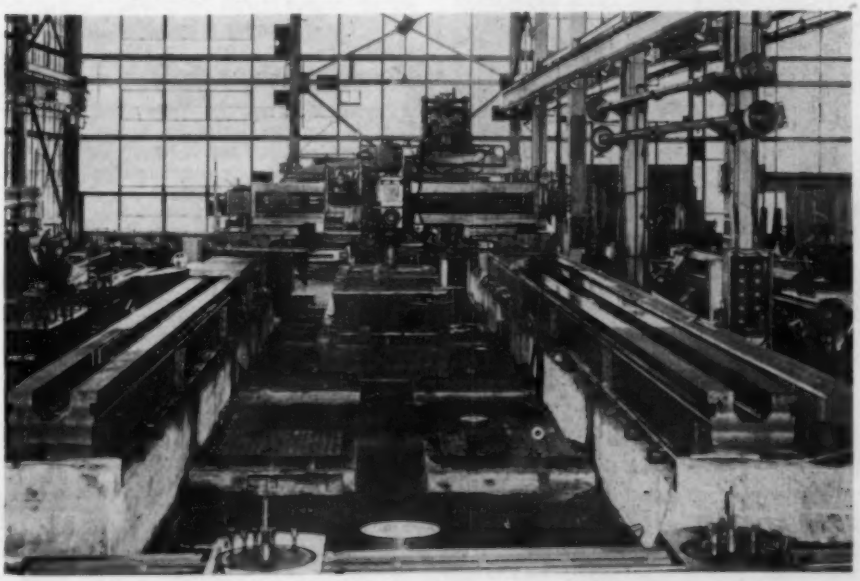
"Also, look at the ASW hardware market. We have the capability of fabricating the largest acoustic detection devices needed by Navy, shipborne as well as stationary. We can build and test them right here, and, when ready for shipment, put them onboard ship right outside our assembly facilities.

"We have 50-ton overhead cranes (46-ft under hook) in the assembly halls. These are able to lift onboard ship anything we build. In the huge antenna field, as well as in the heavy ASW hardware field we can deliver assembled units for shipment out of our doors onto ships north up St. Lawrence, east toward Europe, and south down the coast.

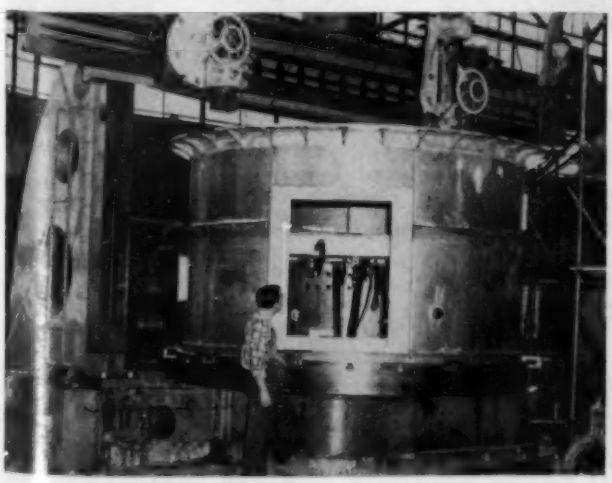
In addition to existing facilities PIC is currently considering buying a surplus Liberty ship. The plan is to convert the ship for ASW work, such as placing buoys and stretching underwater cables. This would eliminate the problem of packaging for shipment, a costly proposition when one considers that the packing of a single unit of hardware may run as high as $30,000 to $40,000. The ship would also be used as an oceanographic research vessel.

Looking to the future, Mr. Kamen says: "The availability of an important scientific facility with skilled manpower for every phase of machining, sheet metal production, heavy fabrication, and assembly should make Portland a major tributary to the important New England arteries now feeding our national economy.

"When PIC is producing full blast, Portland should no longer be a labor distress area, for the plant has a capability of well over $30 million yearly volume and can employ 3,000 people like it did during the war."



PIC 17 x 80 ft horizontal milling machine.



BMEWS installation scanner drum.

Plastic dome 26-ft die plate.

new UE literature

Switching News

Micro Switch's publication, "Uses Unlimited", Vol. 12, No. 2. includes descriptions of new types of switches, such as miniature sealed limit switches for aircraft, missiles, and marine, plus application examples. Use of switches on Pioneer V's historic journey around the sun is also described.

Circle Reply Card No. 101

Power Tubes Bulletin

"Hydrogen Thyratrons: Theory and Application" is General Electric Co.'s new 20-page bulletin, PT-49, only source book for this class of tube available to commercial equipment designers. Schematics, graphs, and charts are included, plus complete technical descriptions and data for the GL-7390, GL-7390-A, and GL-7890.

Circle Reply Card No. 102

Glass Polyester Selector

A selection guide for glass polyesters-water-resistant glass-mat laminates and molding compounds for Class B insulation applications — is offered by Westinghouse Electric Corp. in a new 8-page brochure (B8216). Physical and electrical properties of 10 grades of glass-mat laminates and three grades of glass molding compounds are given.

Circle Reply Card No. 103

High Temp Dry Lubricant

General Magnaplate Corp. has a four-page brochure which details the latest test results of the use of Hi-T-Lube, a revolutionary new high temperature dry lubricant, exclusive product of the corporation. Full information about Hi-T-Lube is given.

Circle Reply Card No. 104

CO_2 Sensor Brochure

Beckman Instruments, Inc.'s new brochure describes a Glass Electrode Carbon Dioxide Sensor designed for use in closed cycle rebreathing systems.

Circle Reply Card No. 105

Oxygen Sensor

A Polarographic Oxygen Sensor is described in an illustrated brochure published by its builder, Beckman Instruments, Inc. The sensor which can be used in applications where potential toxicity exists, is one and a half by two in. in configuration and weighs two and a half ounces.

Circle Reply Card No. 106

Computer Technology Lit

"New Solutions in the Science of Simulation," a 20-page, illustrated brochure by Computer Systems, Inc., details the latest advances in computer technology and equipment. Included is a report on the revolutionary new 5800 DYSTAC (Dynamic Storage Analog Computer).

Circle Reply Card No. 107

Optional Equipment

A brochure explaining the operation of seven new devices developed by the Computer Div. of Philco Corp. as optional equipment with the Philco 2000 electronic data processing system is now available. Each device permits a more comprehensive and effective use of the Philco 2000.

Circle Reply Card No. 108

"Scotchcast" Brochure

A newly published brochure listing properties and data for "Scotchcast" brand electrical resin No. 241 is available from Minnesota Mining and Manufacturing Co. Suggestions for handling, storage and use are included with the list of physical and electrical properties covering the two-part filled, semi-flexible epoxy resin system of 100 percent solids.

Circle Reply Card No. 109

Micro Switch Catalog

A new one-page data sheet covering Catalog Listing 41HRi-S has been released by Micro Switch. It includes details of construction, characteristics and electrical rating, and pricing information. Data sheet includes dimensions drawings, charts, and photographs as well as other descriptive technical information.

Circle Reply Card No. 110

Transitron Catalog

Additional bulletins are available to up-date your Transitron yellow master catalog from Transitron Electronic Sales Corp. Bulletin includes "Silicon Diodes", "Regulators and References", and "Silicon Transistors".

Circle Reply Card No. 111

Nuclear Catalog

Hamner Electronics Co., Inc.'s new illustrated, 40-page catalog describes nuclear instruments and systems, designed to perform a given counting or analyzing function. The catalog provides complete technical specifications and valuable application aids.

Circle Reply Card No. 112

Bendix G-15 Computer

A three-year report on how a Bendix G-15 computer aided and speeded research at American Viscose Corp. is available from Bendix Computer Div. The four-page bulletin is Application Report Number 15 — "Computer Aids Research at American Viscose".

Circle Reply Card No. 113

Technical Data Sheet

John Oster Manufacturing Co.'s newly printed catalog page contains illustration, outline drawing, schematic and complete technical details including specifications, component parts and applications of 3-in-1 BDH Indicator which provides on a single indicator face, information on two relative bearings, distance and magnetic heading.

Circle Reply Card No. 114

new u e products

Shock-Proof Digital Voltmeter

A new explosion-proof digital voltmeter, that can withstand a bone-crushing 50G shock has been developed by Cubic Corporation.

Already chosen for Polaris-armed submarines, the Model 2100 meter is ideal for use during aircraft and missile fueling operations, pipeline pumping stations, and other critical environments. This precision voltmeter is immune to corrosive salt spray or chemicals and will actually operate underwater. The advanced engineering of Cubic's transistor-driven stepping switch design provides extraordinary reliability and accuracy. With automatic ranging and polarity the Model 2100 has a range from 1 millivolt to 1000 volts with an accuracy of 0.01%. Resistance scale is from 0.1 ohm to 10 megohms. Built for wide-range precision, attenuator accuracy is 0.003% and bridge linearity is 0.003%. Noise rejection at 60cps is 80 db.

Circle Reply Card No. 125

High-Power Magacycler

The new HP line of high power output Magacyclers, frequency and pulse rate to voltage converters, is now available from Pioneer Magnetics Inc. These static converters produce an output voltage or current directly proportional to input frequency or pulse rate and cover the audio range from 5 cps to 12KC.

Circle Reply Card No. 126

Sensitive Magnetometer

An extremely sensitive and compact magnetometer, suitable for measuring anomalies of 0.1 gamma or less, has been developed by the Arnoux Corporation. Applicable in both missiles and marine and geodetic activities, the device measures magnetic fields and relays data in digital or analog form.

Circle Reply Card No. 127

Electric Servo Actuator

American Electronics, Inc. has announced a new 8-milli second response electric servo actuator for the control of flight surfaces of missiles. With a constant speed miniaturized motor as its source of motion, each flight control surface is directly connected to its own actuator. As much as 50 per cent weight savings are gained over the hydraulic systems with these electric actuators.

Circle Reply Card No. 128

Weir Drive Motor

The Electro Products Division of Western Gear Corp. now manufactures a Weir Drive Motor for use in nuclear radiation environment. It has an output of 150 ounce/in. with a maximum temperature rise of 40°C.

Circle Reply Card No. 129

Electrical Pressure Gauge

Hastings-Raydist, Inc. announced a new electrical pressure gauge which operates on a thermopile principle and is intended for use in air and gaseous systems. It is suited for remote measurement, alarm or control of pressure in the range of 0-2500 psig.

Circle Reply Card No. 130

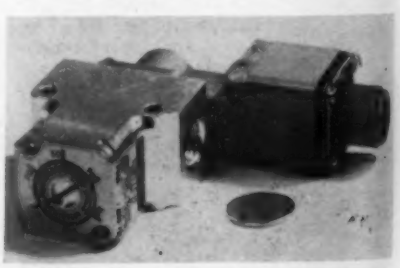
Fuel-Cell Electrode

The Exide Industrial Marketing Division of the Electric Storage Battery Company has developed an advanced type of electrode for use in fuel-cells, a direct fuel-to-electricity power source.

Circle Reply Card No. 132

Pressure Switches

A small, lightweight device which actuates an electric circuit when pressure or flow becomes abnormal has been developed by Pall Corp. These adjustable pressure switches provide reliable indication over the range of 15 to 200 psid and can withstand pressures up to 5000 psi.



Circle Reply Card No. 134

Printed Board Connector

A device for connecting flat conductor cable to printed circuit boards or to flexible etched circuitry without solder has recently been introduced by Thomas Betts & Co. The elimination of crimped and soldered joints appreciably reduces installation time and affords a high order of reliability.

Circle Reply Card No. 133

Screw-Type Connectors

The introduction of a complete line of microminiature screw-type coaxial connectors has been announced by Electro-Physics Laboratories. Minimum voltage breakdown is 1500 VAC and contact resistance is 0.5 milli-ohms maximum. The connectors are available in 50, 70 and 93 ohm impedances and are universally interchangeable.

Circle Reply Card No. 135

Expansion Joints

High-precision bellows-type expansion joints of stainless steel to fit standard pipe sizes from 3 in. to 72 in. nominal diameter are being marketed by Pathway Bellows, Inc. The firm's method of manufacture provides very high or low spring rates and pressures and insures good fatigue characteristics and consistent long life.

Circle Reply Card No. 136

Coaxial Cable

A new aluminum sheathed air dielectric coaxial cable developed by the Electronics Division of American Tube Bending Company has the ability to bend to sharp radii without displacement or distortion of center conductor, thus eliminating special configurations and connections in "terminal to terminal" installations.

Circle Reply Card No. 137

Differential Calibrator

A highly accurate portable differential pressure tester and calibrator is being manufactured by Armcorp (American Research and Manufacturing Corp.) for checking gauges, flowmeters, transducers and other equipment.

Capa[illegible]e of remote checking, it incorporates its o[illegible] pressure source, and has a differential press[illegible]e range of 600 inches in water.

Circle Reply Card No. 138

Low-Cost Dataplotter

Able to accept analog as well as digital inputs, a compact digital plotter from Electronic Associates, Inc. provides improved accuracy and speed for converting data to graphic displays. Input can be in the form of punched card, tape or keyboard.

Circle Reply Card No. 139

Synchro Mount Encoder

The Norden division's Ketay department is producing a non-contacting Gray code magnetic shaft angle encoder with accurate readout at 10,000 rpm and exceptionally low torque. Clockwise or counter-clockwise rotation is available for increasing count.

Circle Reply Card No. 140

Automatic Data Logger

A low-cost automatic data logger, the RS2, has been built by Non-Linear Systems, Inc., as an integrated scanning, measuring and printing system. Designed for applications requiring high accuracy, the RS2 provides 4-digit voltage readings and has 2 digits for input channel identification.

Circle Reply Card No. 141

"Dyna-Mite" Relay

Currently being used in a major ICBM program is a mite-sized relay with a volume of 0.048 cubic inches built by Control Dynamics Corp. The Dyna-Mite is rated at .25 amps,

with a contact life of 100,000 cycles minimum at resistive load of 28 VDC. Its size makes it ideally suited for control and radar systems as well as computers.

Circle Reply Card No. 142

Shielded Marine Cable

A new marine cable, offered by Research Manufacturing Corp., is finding applications in seismic and underwater sound instrumentation because of its good durability, non-hygroscopic construction and high tensile strength.

Circle Reply Card No. 143

Recorder/Reproducer System

Data Stor, division of Cook Electric Co. recently designed a Recorder/Reproducer System for use in the ASROC Anti-Submarine Weapon. It aids in target identification and provides a permanent record of "raw data" for a 13-hour period. Signal analysis is accomplished by the use of a unique frequency spectrum analysis technique.

Circle Reply Card No. 144

Laboratory Tester

An All-Semiconductor general purpose laboratory instrument for designing, testing and demonstrating PNP transistor switching circuitry is now being sold by the Navigation Computer Corp. The unit provides all necessary supply voltages and waveforms in a single portable package.

Circle Reply Card No. 145

Motor/Amplifier Unit

In response to the needs of major weapons manufacturers, Lumen, Inc. developed a packaged unit containing a magnetic amplifier, a drive network and a motor. The unit functions at extremely low levels of signal current and is capable of producing a 10 watt output.

Circle Reply Card No. 146

Servo Amplifiers

High-temperature transistorized servo amplifiers are being manufactured by the Electronics Division of the Bulova Watch Company, Inc. They range in size from 1 to less than 2 cubic inches and are available in 3.5, 6 and 12 watt sizes. **Circle No. 147**

Signal Amplifier

Miniature, transistorized, signal amplifiers from Statham Instruments, Inc. provide total utilization of low level signals. Output is −0.5 to +5 volts DC with a power requirement of 35 millamperes at 28 volts DC. Frequency response is flat from 0-2000 cps.

Circle Reply Card No. 148

Vapor Contaminant Filter

A supplemental vapor contaminated filter is now available for removal of water vapor and other contaminants from air, nitrogen, oxygen and similar gaseous matters in pressure lines. The filters are manufactured by Servomechanisms, Incorporated. **Circle No. 149**

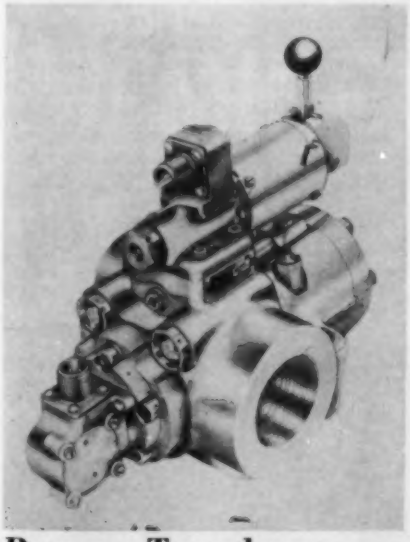
Air Sampler

An improvement in the portable, high volume air sampler marketed by the Staplex Company enables the machine to collect larger samples of air to be tested in a much shorter length of time. It is being used to measure airborne matter of all kinds.

Circle Reply Card No. 150

Pneumatic Valves

A new "regulator type" shut-off valve, model MV-200, built by Marotta Valve Corp., eliminates the hazard of auto-ignition by the use of a pressure sensing actuator element with a pneumatic timer. The valve operates with pressure differential of 0-6000 psi applied in either direction. **Circle No. 151**



Pressure Transducer

A rugged precision pressure transducer designed to measure absolute, gauge or differential pressures of corrosive or non-corrosive gases or liquids in the 0-5 and 0-500 psi full-scale range is now available from Fairchild Controls Corp.

Circle Reply Card No. 131

Rugged Tetrode

Amperex has announced a type 7609 RF power amplifier tetrode designed for stringent environmental conditions. A forced air cooled, external anode, tetrode, it will operate at frequencies up to 500 Mc and withstand sweep frequency vibrations of 10G, 25 to 2000 cycles, and 30 degree bump tests. Ideal for mobile and aircraft transmitters.

Circle Reply Card No. 152

Thermoelectric Power

A remarkable new power package that produces usable thermoelectricity has been announced by Harco Laboratories. Capable of series of parallel connection, these miniature compact generators deliver 2.5 milliwatts of power with a current into 100 ohms of 5 milliamperes.

Circle Reply Card No. 153

Subminiature Tubes

The first frame grid subminiature tubes in the industry have been developed by Ratheon Company's Industrial Components Div. Featuring a low feed-back capacitance, high transconductance to-plate current ratio and low noise capacitance, the tubes are enclosed in 0.375 by 1.25 inches T-3 button envelopes.

Circle Reply Card No. 154

Hermetic Diodes

Two microminiature glass diodes, the TI-2 and TI-6, are now being marketed by Texas Instruments, Inc. Smaller than the head of a pin, these diodes mean a reduction in volume of 50:1 over conventional diodes with similar characteristics. A revolutionary concept in high-density packaging.

Circle Reply Card No. 155

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people and employment

Simplex Wire & Cable Co. has announced the association of **V. Reed Manning,** formerly with Alpha Corp., as assistant to the vice president-engineering. He will be responsible for communication and electronic systems.

Kenneth M. Gentry, recently retired from the Navy, has joined Motorola Military Electronics Div. as associate director, research and development for Undersea Warfare and ECM.

Two new appointments at Cinch Manufacturing Co. have been announced: **Roy Witte,** vice president in charge of research and development, and **Philip Martsolf, Jr.,** chief engineer for manufacturing. **Mr. Witte** was formerly manager of engineering, Haydon Div. of General Time. **Mr. Martsolf** comes from Arnold Engineering Co., where he was chief mechanical engineer.

Manning

Gentry

Appointment of **Seymour Hunt** to the newly-created position, chief technical staff consultant has been announced by Gulton Industries' Alkaline-Battery Div. He was previously associated with Westinghouse Corp.'s radio and TV division.

New engineering application manager for the Systems Div. of Epsco, Inc. is **Henry Schrimpf.** Before joining Epsco, he was with Minneapolis-Honeywell Regulation Co.'s DATAmatic Div.

James B. Connelly has been named director of field engineering at Sperry Gyroscope Co. With Sperry since 1939, he was most recently superintendent of the company's Wichita, Kan. service area.

Alpha Corp. announced the appointment of **Rear Admiral Henry C. Bruton,** USN (Ret.) as director of their Fleet Communications Div. He will be headquartered at the company's Richardson, Texas plant.

Robert E. Morris has been named resident contract engineer for Technical Materiel Corp.'s Mediterranean Area U.S.N. He will be located in Fort Lyautey, French Morocco.

William M. Ellsworth is the new manager of PneumoDynamics Corp.'s Systems Engineering Div. Before joining the company in 1958, he held a key supervisory post at the David Taylor Model Basin.

Appointment of **Robert W. Mayer** as manager-engineering for the General Electric Ordnance Dept. has been announced. Prior to his present assignment, he was consulting engineer for the department's advance projects section.

Dr. T. J. Bulat has moved to the position of manager of sonic engineering with the Pioneer-Central Div. of The Bendix Corp. He previously headed the applications laboratory for the sonic energy products group of the division.

Alemite and Instrument Div. of Stewart-Warner Corp. announces the appointment of **Paul F. Allmendinger** as manager of engineering. He came to the corporation in 1958 from Fairbanks-Morse.

Succeeding J. Donald Moulton, retired, as manager of engineering and development at the Electric Storage Battery Co.'s Nickel-Alkaline Battery Div. is **William W. Smith.** He moves to this new post from within the company where his most recent assignment was manager of alkaline battery development in the engineering dept. of ESB's Exide Industrial Div.

Robert R. Beachler, Jr., physicist and administrator, has been elected vice president of the Leach Corp. Before joining Leach, he had been associated with North American.

Ellsworth

Allmendinger

Promoted from the position of assistant manager at Control Instrument Co. to that of general manager of the company is **James E. Myers.** With the company since 1949, he has held several executive positions in the organization prior to his new assignment.

Dr. Harold R. Luxenberg, former Ramo-Wooldridge and Litton Industries scientist, has joined the Westwood Div. of Houston Fearless Corp. as reconnaisance systems head. He will be responsible for technical direction of the company's Information Acquisition and Interpretation system.

Communications Accessories Co. has named **Emil L. Badway** chief engineer, transformer design. Prior to his new appointment, he was design engineer with the company, having held a similar position with the New York Transformer Co.

Dr. M. J. DiToro has joined the technical staff of Cardion Electronics, Inc. as vice president for research. He comes to Cardion from PRD Electronics, Inc.

Director of engineering at Consolidated Avionics Corp., **William Perzley,** has become vice president of the company. He was formerly supervisor for American Bosch Arma Corp.

Appointment of **Robert L. Hirsch** to the position of assistant to the vice president, at Aerojet-General's Solid Rocket Plant in Sacramento has been announced. He recently completed a term as manager of Aerojet-General's Washington office.

Chief engineer of Hoffman Electronics Corp.'s new Instrument Div. is **T. H. Abrahams.** He comes to Hoffman from the Douglas Aircraft Co. where he was senior research analyst.

Thomas R. Maher has been named director of manufacturing at Packard Bell's Technical Products Div. He joins Packard Bell from Ryan Aeronautical Co.'s Electronics Div. where he was manager of operations planning.

William H. Foster has joined Electro-Optical Systems, Inc. as manager of the Advanced Technology Dept. of the Advanced Electronics & Information Systems Div. Prior to his position at EOS, he was electronic project manager at Librascope.

American Systems, Inc. announces the addition of **Dr. Manlio B. Melillo,** an authority on chemical deposition of magnetic materials, who will manage their new magnetic components laboratory. He was previously chief chemist for the Electrada Corp.

Heading Telechrome Manufacturing Corp.'s new Washington, D. C. office is **Robert Adams,** recently appointed manager of military products for the company. He was formerly manager of eastern operations for Packard-Bell Electronics Corp.

Filling the newly created position of manager, military plans and programs, at Loral Electronics Corp. is **Leon F. Collier.** He came to Loral after many years with the Dept. of

Smith

Badway

Navy. At the same time, **Michael Korek** was named assistant manager. He was formerly with the Link Div. of General Precision, Inc.

Dr. Frederick Seitz, head of the Physics Dept. of the University of Illinois and one of the nation's leading physicists, has been elected a director of American Machine & Foundry Co. An international authority on solid state and nuclear physics, he is currently president of the American Physical Society.

Recently appointed director of science studies of the Underwater Society of America is **Dr. D. K. Patton.** In this position, he will be responsible for the development of a scientific program concerning the art of diving and its applications.

Three new key appointments in General Precision, Inc.'s Engineering Div. are: **John C. Forrest,** director; **Dr. Frank N. Gillette,** associate director; and **Louis L. Pourciau,** head, Industrial Products Dept. All were promoted from prior positions within the company. **Mr. Forrest** was formerly chief engineer for radar and special products, and **Dr. Gillette** held the position of chief engineer for industrial products. **Mr. Pourciau's** post was head of the Electronic Dept., Industrial Products.

Dr. Yujiro Yamamoto has joined Borg-Warner Controls as head of recorder engineering at Santa Ana, Calif. Before coming to Borg-Warner, he was a research engineer in the Dept. of Engineering Research at the University of California at Los Angeles.

Ionics, Inc. announces the appointment of **Stuart C. McGriff** as assistant director of research and manager of the firm's Washington, D.C. office. Prior to joining Ionics, he was product manager for fuels and propellants at Gallery Chemical Co.

Dr. Antonio Ferri has been elected president of General Applied Science Laboratories, Inc. He was executive vice-president and director of research at GASL prior to his election, and was one of the founders of the company when it was organized in 1956.

Heel and Toe Watch

The U.S. Navy's submariners are the only ones in the Pentagon, it's said, standing a heel and toe watch. That's salty talk for around-the-clock close vigilance. The statement emphasizes the critical nature of the undersea environment to this nation's security—also the still not fully comprehended future that awaits mankind in both war and peace beneath the ocean waves. For this reason, with this issue, this column becomes a regular feature of Underwater Engineering. It, like the submariners, will keep a close watch on the whole state of the undersea art; tactical and strategic developments in ASW and PSW; news, views and prospects of the Navy's total underseas effort; and constitute, in effect, a sounding board for comments and ideas.

* * *

Three USO's a day: that's the fleet's average of sightings of "unidentified submerged objects"—thought almost certainly to be snooping Red submarines. Taking into account the low chances of spotting even a moderate proportion of lurking submarines, this lends strong support to the Navy's concern over the Red undersea menace.

* * *

First the sonar, then the sub: That's more and more the trend in ASW submarine design. A recent development spots highly sensitive transducers all along the submarine's hull—enabling a) more efficient utilization of the low frequencies and b) more effective vectoring for close determination of range and bearing.

* * *

Serious structural fatigue problems may be in the offing for deep-diving nuclear submarines. Evidence has been noted in the hulls of some of the older craft. Reason: Much greater depths to which they go, and the fact that their high-speed maneuverability results in many more pressure cyclings than are encountered by conventional boats. There may also be problems of residual stress worked into the structure due to plastic deformation under deep water pressures. Query: What's the work hardening effect of repeated high pressure cycling? This may be the beginning of our first real insight to some of the problems peculiar to design for repeated operation to great depths. Watch it.

* * *

Home-made bombs for echo ranging? Underwater explosions possess certain advantages in sonic search and detection—as well as disadvantages. However, an obvious limitation to this method of making noise has been the great numbers of these explosive devices that would have to be carried for them to be useful over any period of time—impractical on already heavily-crowded submarines. Now, however, a proposal is under consideration to equip undersea craft with equipment for the electrolysis of water into hydrogen and oxygen with which the submarine could manufacture its own explosive devices as required.

* * *

One of the big guessing games around the Pentagon these days is: Who's going to be the next Chief of Naval Operations? Oft-mentioned candidates include: Vice Admiral George W. Anderson, Admiral James S. Russell, Rear Admiral Lawson P. Ramage, and Vice Admiral Wm. F. Raborn, Jr. We've heard good reasons why each should or will get it; and "incontrovertable" evidence why each won't. What's your guess and why?

* * *

AUTEC requirement everyone's talking about: Hydrophone arrays at precise and frequent intervals from 5,500 feet down to sealevel that must be held within a five-foot depth variation. AUTEC problem everyone seems to be ignoring: How are you going to anchor and hold these arrays to this tolerance on a largely unknown bottom and in an ocean of shifting (often rapid) currents?

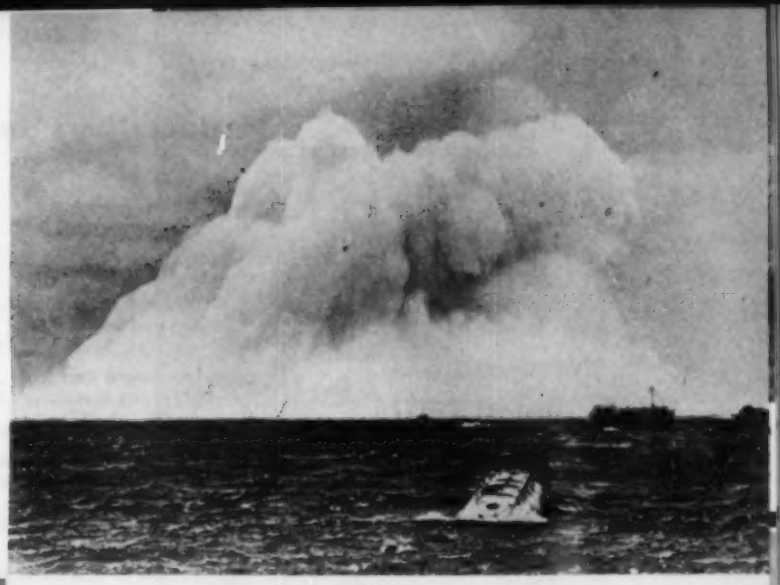
* * *

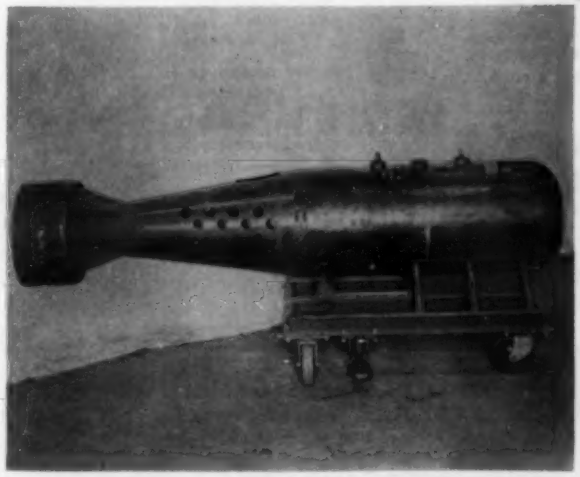
The new lid on Pentagon information doesn't make any more sense than those that preceded—even less when you consider that people are supposed to learn from experience. In fact it's getting ridiculous. Now when you call a Pentagon information officer, he doesn't say "hello" but instead when answering the phone, he says "no!"

—Captain Nemo

UE NEWS PHOTOS

Navy Strips Wraps From Atomic Lulu





WHEN THE NORMALLY RETICENT NAVY TALKS about Lulu, they cite some statistics that would make any girl proud. Lulu is smaller than Betty, weighs 1/3 as much, is much easier to handle, can do the job better, will stand up longer under the strain, and requires less care — only about 50-60 man-hours per month. The only bad fault — and it's a good one as far as the Navy is concerned — is that she makes more noise than Betty. Both are nuclear depth bombs for use against submarines.

The air-droppable Lulu is shown here in these latest photographs released by the Navy. She created this vast waterspout, top, several years ago before suspension of atomic tests. Her relative size is indicated by center and lower left photos. Conceived, designed and developed by Naval Ordnance Laboratory, she fits snugly under wing of PB5M, lower right. General Mills participated in development, performed production engineering, and is currently producing the weapon.

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PUBLISHED BY
Sheffield Publishing Company
640 Washington Building
Washington 5, D. C.
Telephone: District 7-8570

Advertisers Index

NOTE—Underwater Engineering circulation is executed on a controlled unpaid basis. Engineering and management personnel actively engaged in the areas of undersea warfare and oceanography are considered qualified applicants. Use the self-addressed post card in this issue or write to Circulation Dept., 2775 S. Moreland Blvd., Cleveland, Ohio.

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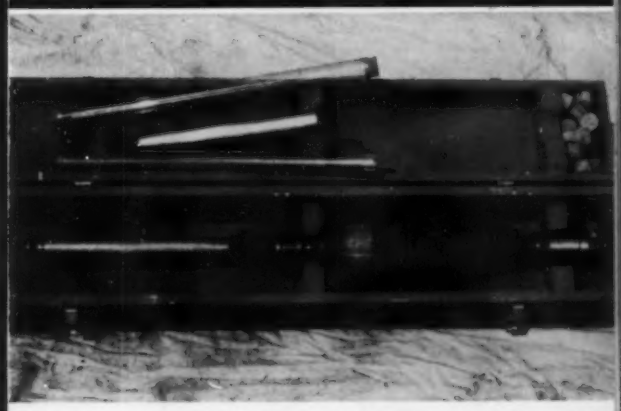
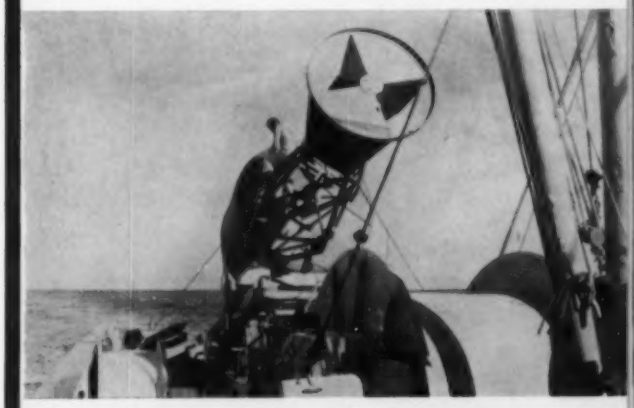
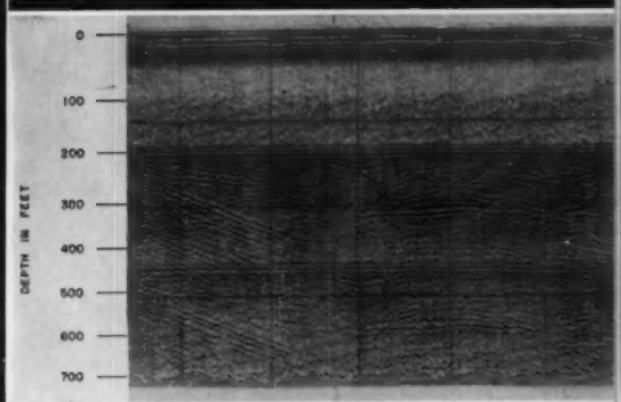
The 136′ G. W. PIERCE, one of MARINE'S five research vessels, including the 65′ LORD RAYLEIGH, the 83′ H.J.W. FAY, the 98′ H. C. HAYES, and the 112′ LORD KELVIN.



A multipurpose #211 Gravity Coring Tube Kit. A stock of Sediment Coring Apparatus in sizes up to 1200 pounds is maintained at the ALPINE Norwood, N.J. plant.



This 12,000 lb. mooring buoy was recently anchored in 5,000 feet of water by MARINE for the U.S. Navy.



Read similarly to an echo sounder trace, this Sparker reflection record, made by ALPINE during foundation investigations for the English Channel Tunnel, shows the sub bottom strata interrupted by a fault.